Instruction

MI 611-211
October 2005

870ITPH Intelligent Electrochemical Transmitter

for pH, ORP, and Ion Selective Electrode Measurements

Invensys®
FOXBORO®

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1. Introduction

The 870ITPH Intelligent Transmitter converts pH, ORP, or Ion Selective Electrode measurements to a 4 to 20 mA and/or digital output signal depending on the model selected and the configuration implemented.

The analog only output version (Model 870ITPH-A) supports configuration, calibration, and diagnostic troubleshooting locally at the front panel. The transmitter has one 4 to 20 mA dc output which can be software configured (connected) to temperature compensated measurement, uncompensated (absolute) measurement, or temperature.

The digital output version (Model 870ITPH-F) supports configuration, calibration, and diagnostic troubleshooting locally at the front panel, via a PC-based configurator anywhere on the signal leads, or from any I/A Series workstation via an Intelligent Transmitter Fieldbus Module. The digital output version supports either digital only communication or a hybrid 4 to 20 mA dc/digital communication as configured. When operating in either of these modes, the transmitter continuously outputs three digital measurement values: temperature compensated measurement, uncompensated (absolute) measurement, and temperature. In the 4 to 20 mA mode, you may assign the output to any one of the three measurement parameters.

Quick Start

The purpose of this section is to:

- Help you to wire your transmitter
- Familiarize you with the instrument configuration as received from the factory
- Assist you in verifying that your transmitter is in calibration
- Explain normal operation in Measure mode.

Wiring

Your 870IT is a 2-wire transmitter. As such, it transmits output over the same two wires through which it receives power. If your transmitter was specified with analog communications (870ITPH-A), you must supply its power source. If it was specified with digital communications (870ITPH-F), power can be provided via the I/A Series Fieldbus Module. Connect this power/output signal to the power terminals and the signals from your measurement sensor to the appropriate terminals near the top of the case as shown in Figure 1.

⚠ WARNING

Wiring installation must comply with any existing local regulations.

⚠ WARNING

A safety agency certified energy barrier must be used with this apparatus to meet agency certification requirements. See MI 611-206 (FM/CSA) or MI 611-208 (ATEX) for details.

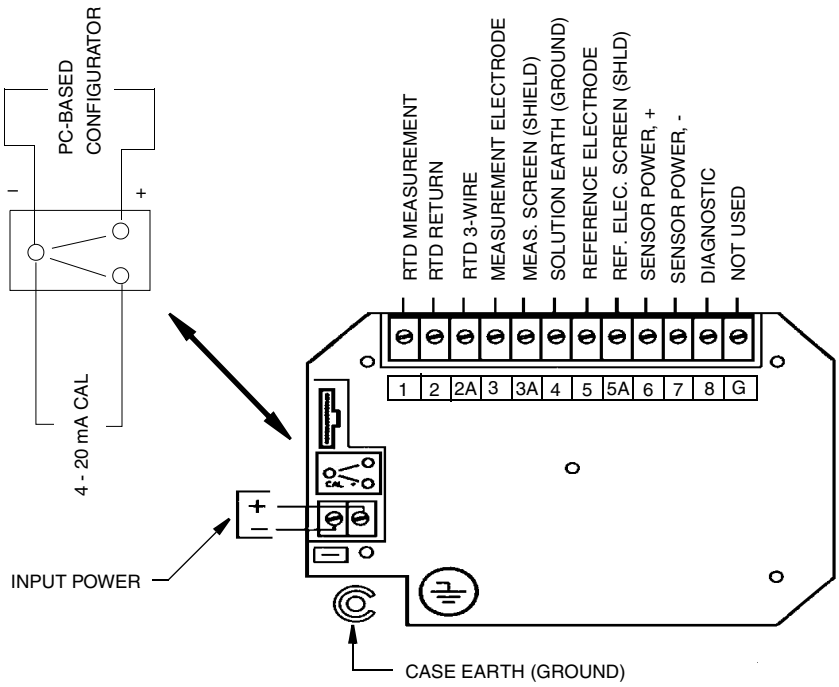


Figure 1. Wiring

Factory Default Passcode

The factory default passcode for both minor and major passcodes is 0800.

Checking Factory Configuration

Following the structure diagrams in Appendix A and using the arrow keys, you can step through the product structure as configured in the factory. The factory default values are listed in Appendix B. There is space provided to make notations in the last column of the table that comprises this appendix.

Verifying Valid Measurements

Your transmitter was calibrated at the factory. Therefore, you should not have to calibrate it.

However, if you wish to check your calibration, place your sensor in a solution of known value and, using the Down arrow key, check that the temperature on the second line of the display agrees with the actual temperature of the solution. Then check the value on the top line of your display. If the value does not agree with the known value of the solution, recalibrate your transmitter. The simplest method of doing this is to perform a single point manual calibration using the solution approach. See “Manual Calibration” on page 31.

Basic Operation in Measure Mode

Measure is the normal operating mode of your transmitter. The pH, ORP, or ISE measurement is shown on the top line of the display. The second line of your display shows the absolute value of the sensor signal in millivolts, the output in 4 to 20 mA, or the temperature, depending on your

configuration. You can view one of the other two selections by using the Up and Down arrow keys. The display will return to the configured selection when the configured **TIMEOUT** time is reached. Configuration errors and transmitter and sensor errors are also shown on your display while in the Measurement mode.

Looking for More Information?

For more detailed information, refer to the following sections of this manual:

- For installation information, refer to "Installation" on page 7.
- For detailed explanation of the controls and indicators, refer to "Controls and Indicators" on page 11.
- For detailed configuration instructions, refer to "Configuration" on page 17.
- For detailed Calibration instructions, refer to "Calibration" on page 30.

For dimensional information, refer to DP 611-163.

General information on this and other electrochemical products are available on line at **www.foxboro.com** (pull down **Products** menu and select **Echem Analytical**).

If you need additional help, please call 1-866-746-6477 in the U.S.A. or contact your local Invensys Foxboro representative.

Reference Documents

Document[a]	Document Description
DP 611-163	Dimensional Print - 870IT Intelligent Transmitters
MI 020-495	PC20 Intelligent Field Device Tool
MI 020-501	PC50 Intelligent Field Device Tool
MI 020-504	PC50 Intelligent Field Device Tool (FoxCom Communication)
MI 611-206	FM and CSA Intrinsic Safety Connection Diagrams and Nonincendive Circuits
MI 611-208[b]	Electrochemical Products Safety Information (for European installations)
PL 611-153	Parts List - 870IT Style B Intelligent Transmitters

(a) Documents are available on line at **www.foxboro.com** (pull down **Products** menu and select **Documentation**).

(b) Available in many languages on line at www.foxboro.com/us/eng/products/instrumentation/downloads/ecanalyticalsafety/ecanalyticalsafety.htm.

Specifications

Sensors: Virtually any glass or antimony pH, ISE, or noble metal ORP sensor including the following:

PH10 DolpHin™ Series pH Sensor

ORP10 DolpHin™ Series ORP Sensor

871A pH/ORP Sensor (see Note)

871PH pH/ORP/ISE Sensor (see Note)

EP459A Fluoride Sensor

EP460 pH/ORP Sensor

EP462 pH Sensor

EP466 pH Sensor

— NOTE

871A-2, 871PH-1, and 871PH-2 Sensors, although compatible with 870ITPH Transmitters, do not supply full sensor diagnostic capability.

Maximum Distance Between Sensor and Transmitter:

With preamplified sensor: 152 m (500 ft)

With non-preamplified sensor that utilizes a driven shield (PH10-.N, 871A-1, -3; 871PH-5, -6): 15.2 m (50 ft)

Temperature Compensation Inputs:

100 ohm platinum RTD, 2- and 3-wire

1000 ohm platinum RTD, 2- and 3-wire

Balco 3000 ohm RTD

Ambient Temperature: -25 to +55°C

Relative Humidity: 0 to 95% noncondensing

Electromagnetic Compatibility (EMC): The Model 870ITPH Intelligent Transmitter complies with the requirements of the European EMC Directive 89/336/EEC when the sensor cable and I/O cables are enclosed in rigid metal conduit. (See Table 2.)

Power Supply Requirements (for 4 to 20 mA output): 12.5 to 42 V dc (see Figure 2)

Load Limitations (for 4 to 20 mA output): 0 to 1450 ohms (see Figure 2)

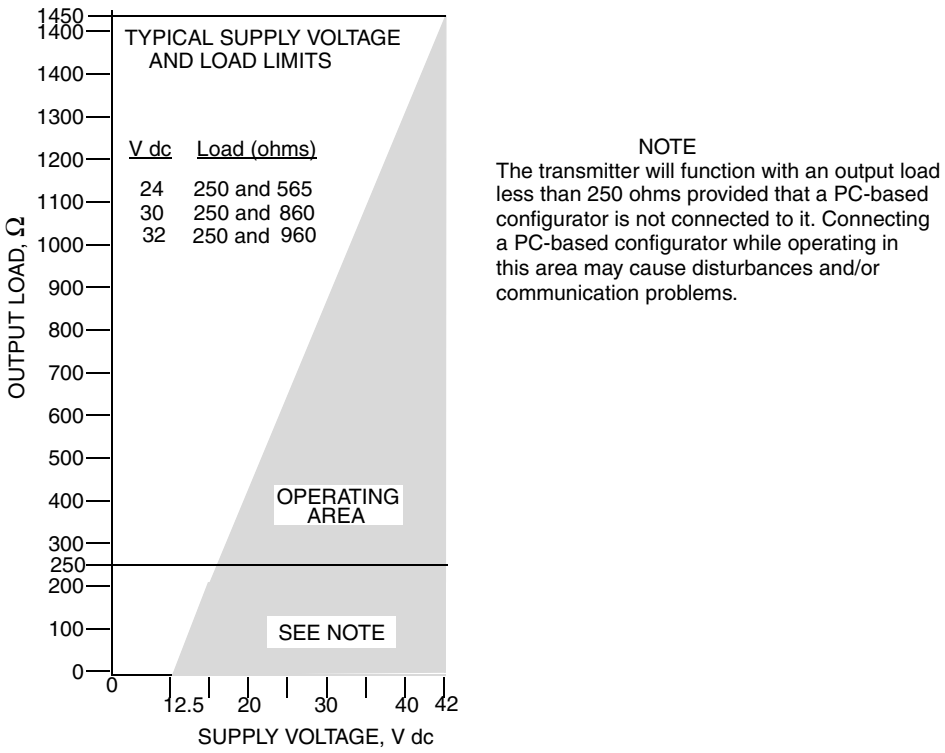


Figure 2. Supply Power vs. Load

Product Safety: The 870IT transmitters have been designed to meet electrical safety descriptions listed in Table 1. For detailed information, or status of testing laboratory approvals/certifications, contact Invensys Foxboro.

Table 1. Product Safety Specifications

Testing Laboratory, Type of Protection, and Area Classification	Application Conditions	Electrical Safety Design Code
ATEX intrinsically safe for II 1 G, EEx ia IIC hazardous locations.	Temperature Class T4 - T6	AAA
ATEX Type n energy limited for II 3 G EEx nL IIC hazardous locations	Temperature Class T4 - T6	ANN
CSA intrinsically safe for Class I, II, and III, Groups A, B, C, D, E, F, and G, Division 1 hazardous locations.	Connect per MI 611-206. Temperature Class T4.	CAA
CSA suitable for use in Class I, II, and III, Groups A, B, C, D, F, and G, Division 2 hazardous locations.	Temperature Class T4.	CNZ
FM intrinsically safe for Class I, II, and III, Groups A, B, C, D, E, F, and G, Division 1 hazardous locations.	Connect per MI 611-206. Temperature Class T4.	FAA
FM nonincendive for Class I, II, and III, Groups A, B, C, D, F, and G, Division 2 hazardous locations.	Temperature Class T4.	FNZ

RoHS/WEEE Compliance Statement

This product is exempt from the European Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS), as provided by Article 2 of that Directive in conjunction with the Product Category #9: "Monitoring and Control Instruments."

This product complies with the European Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE) and is marked accordingly. At end of product life users should contact Invensys Foxboro for return authorization and shipment instructions.

Identification

A data label is fastened to the left side surface of the enclosure. This label provides the model number and other information pertinent to your particular transmitter.

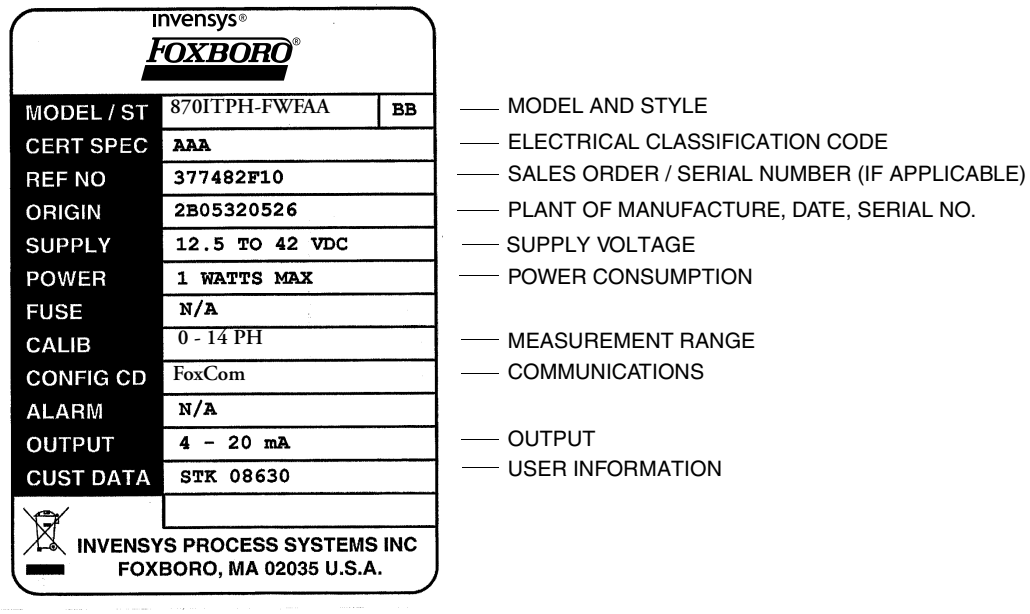


Figure 3. Data Label

2. Installation

Unpacking

1. Remove the transmitter from the shipping container and check for visible damage.
2. Save the container until you determine that no shipping damage has occurred.
   a. If no damage is observed, proceed to the Mounting procedure.
   b. If transmitter has been damaged, notify the carrier immediately and request an inspection report. Obtain a signed copy of the report from the carrier and contact the Customer Satisfaction Center at 1-866-746-6477 in the U.S.A., or contact your local Invensys Foxboro representative.

Mounting

Panel Mounting

Panel mounting of the transmitter is shown in Figure 4. For panel cutout size, space requirements, and other dimensional data, see DP 611-163.

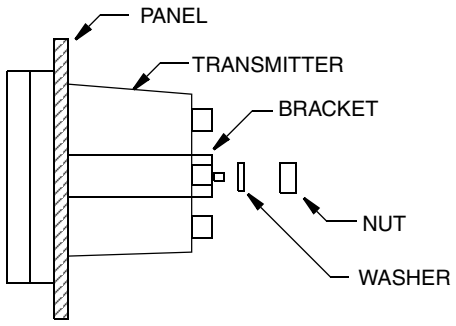


Figure 4. Panel Mounting

Surface Mounting

Surface mounting of the transmitter is shown in Figure 5. Fasten mounting bracket to transmitter using screws, washers, and lockwashers provided. Fasten mounting plate to surface using appropriate hardware. For space requirements and other dimensional data, see DP 611-163.

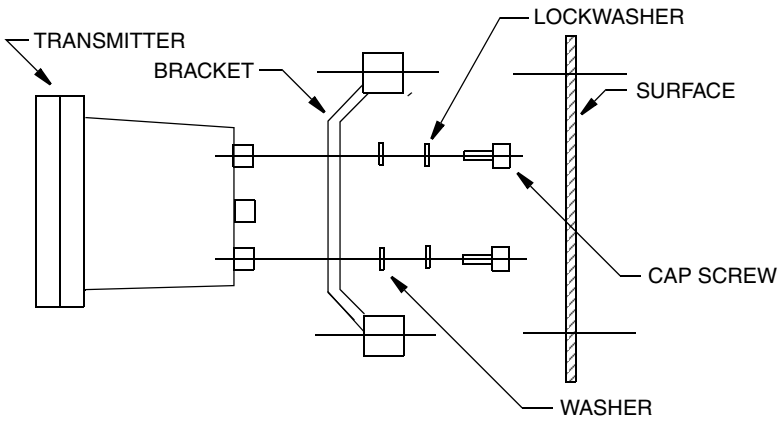


Figure 5. Surface Mounting

Pipe Mounting

Pipe mounting of the transmitter is shown in Figure 6. Securely fasten mounting bracket to a DN50 or 2-in pipe as shown. For space requirements and other dimensional data, see DP 611-163.

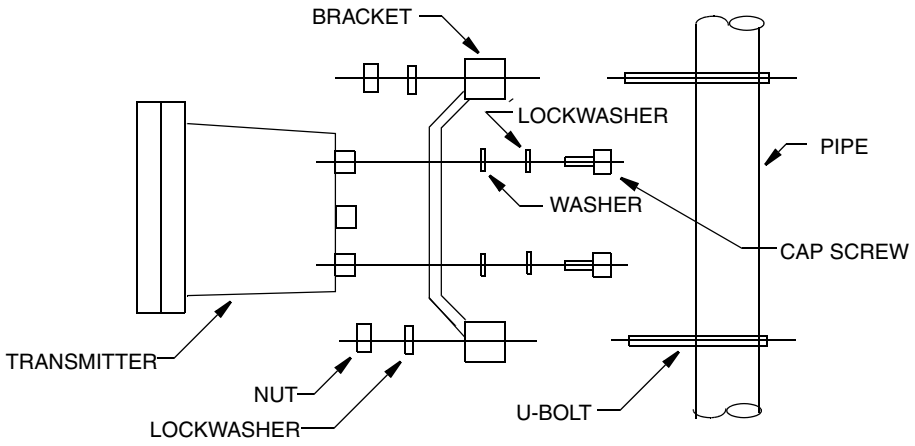


Figure 6. Pipe Mounting

Wiring

Your 870IT is a 2-wire transmitter. As such, it transmits output over the same two wires through which it receives power. If your transmitter was specified with analog communications (870ITPH-A), you must supply its power source. If it was specified with digital communications (870ITPH-F), power can be provided via the I/A Series Fieldbus Module. Connect this power/output signal and the signal from your measurement sensor as follows:

1. Open the hinged case door.
2. Remove the plastic shipping caps from the openings on the bottom of the case and replace with proper fittings. You will be running wires through the left and right openings and capping the middle opening.

⚠ WARNING

Wiring installation must comply with any existing local regulations.

⚠ WARNING

A safety agency certified energy barrier must be used with this apparatus to meet agency certification requirements. See MI 611-206 (FM/CSA) or MI 611-208 (ATEX) for details.

⚠ CAUTION

1. Failure to adequately seal open ports or secure the cover will jeopardize NEMA 4X, CSA Enclosure 4X, or IEC IP65 and will void instrument warranty.
2. To maintain a rating of NEMA 4X, CSA Enclosure 4X, or IEC IP65, wiring methods, conduit, and fittings appropriate to the ratings must be used. Table 2 identifies recommended parts.

⚠ CAUTION

To mimimize RFI/EMI effect, use grounded metal conduit on sensor cable and input power leads.

Table 2. Recommended Conduit and Fittings

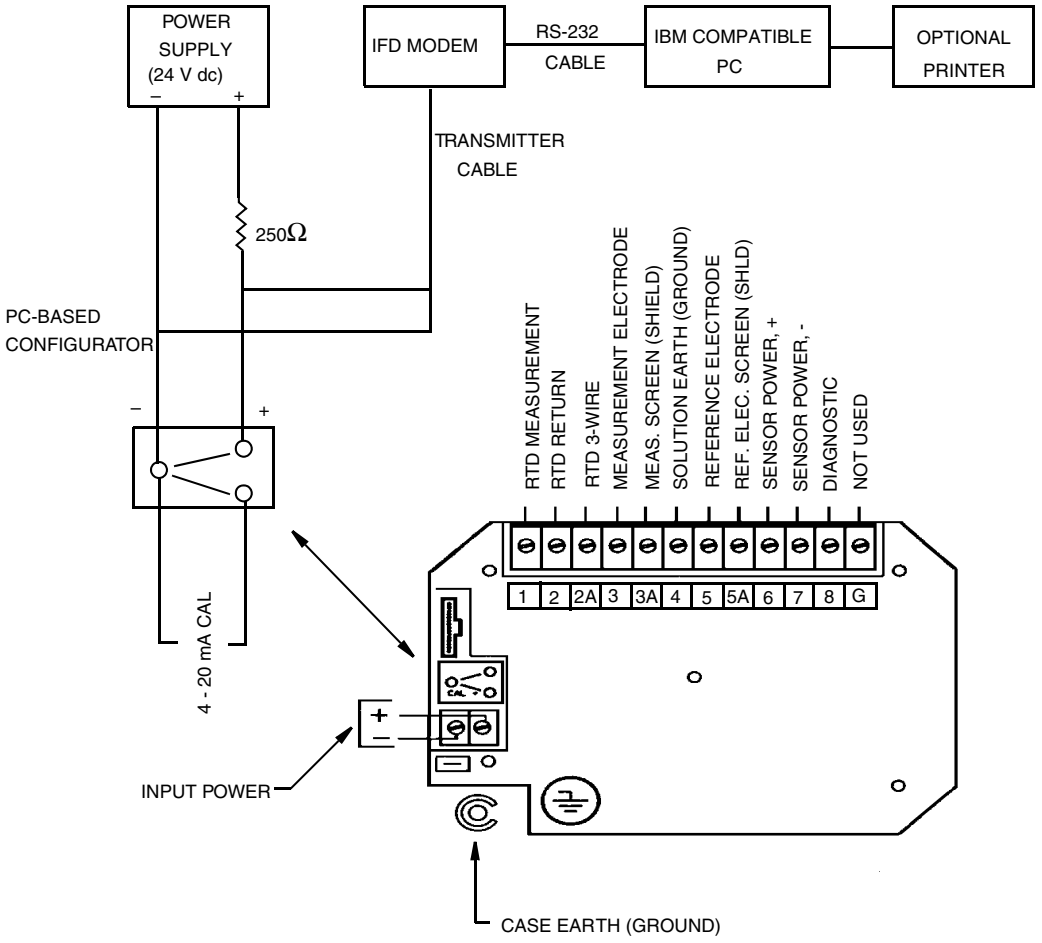
Material	Conduit	Fitting
Rigid Metal	1/2 inch Electrical Trade Size	T&B* #370
Semi-Rigid Plastic	T&B #LTC 050	T&B #LT 50P or T&B #5362
Semi-Rigid Plastic Metal Core	Anaconda Type HV, 1/2 inch	T&B #LT 50P or T&B #5362
Flexible Plastic	T&B #EFC 050	T&B #LT 50P or T&B #5362

*T&B = Thomas & Betts Corp., 1001 Frontier Road, Bridgewater, NJ 08807

3. Bring the wires from your 2-wire input power in the left opening and connect to the input power terminals shown in Figure 7. Bring the sensor cable in the right opening and connect by number to the appropriate terminals near the top of the case per Figure 7.
4. For non-Foxboro sensors with coax cable, connect RTD to terminals 1 and 2, measurement electrode to terminal 3, solution ground to terminal 4, and reference electrode to terminal 5. Solution ground must be wired to a metallic material in contact with the process solution. If not, jumper terminals 4 and 5.
5. For non-Foxboro sensors with triax cable, connect RTD to terminals 1 and 2, measurement electrode to terminal 3, measurement screen (shield) to terminal 3A, solution ground to terminal 4, and reference electrode to terminal 5. Solution ground

must be wired to a metallic material in contact with the process solution. If not, jumper terminals 4 and 5.

6. If you are **not** wiring a temperature measuring device, short terminals 1, 2, and 2A to minimize noise.



NOTES:
1. IF NOT WIRING A TEMPERATURE MEASURING DEVICE, SHORT TERMINALS 1, 2, AND 2A.
2. TERMINAL 2A IS NOT USED WHEN YOUR SENSOR CONTAINS A 2-WIRE TEMPERATURE ELEMENT.

Figure 7. Wiring

3. Operation

Controls and Indicators

Operator controls and indicators are located on the front panel. Figure 8 shows the panel arrangement. Table 3 identifies the function of each element.

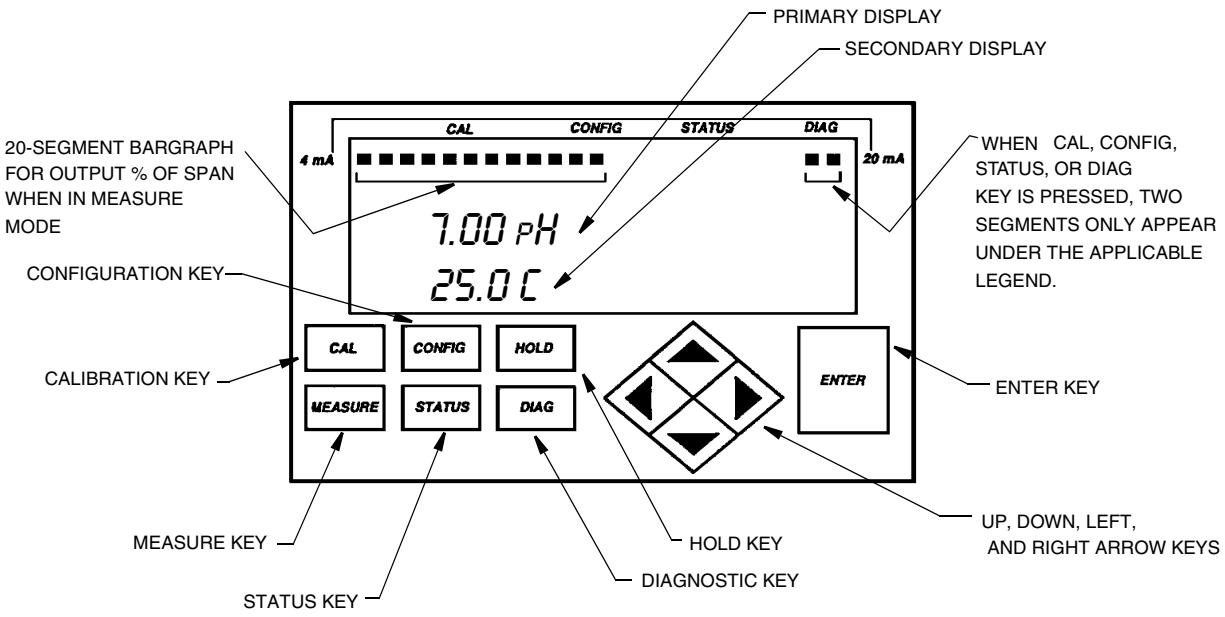


Figure 8. Indicators and Controls

Table 3. Indicators and Controls

Control/Indicator	Function
Digital Bargraph	Displays percent-of-range indication.
Primary Display	Displays measurement and some error messages.
Secondary Display	Displays the absolute value of the measurement signal in millivolts, the output in 4 to 20 mA, or the temperature, and error messages and configuration/calibration prompts.
CALibration Key	Places transmitter in Calibration mode. This enables you to calibrate the transmitter automatically to your buffer solutions or manually to values entered.
CONFIGuration Key	Places transmitter in Configuration mode. This enables you to configure the value or status of each parameter required for your application.
HOLD Key	Places transmitter in Hold mode. This enables you to hold the output at a determined value while configuring or calibrating the transmitter or performing sensor maintenance.
MEASUREment Key	Places transmitter in Measurement (normal operation) mode.

Table 3. Indicators and Controls (Continued)

Control/Indicator	Function
STATUS Key	Places transmitter in Status mode. This enables you to view the measurement and system parameters and thus assess the performance of the loop.
DIAGnostics Key	Places transmitter in Diagnostic mode. This enables you to further identify specific errors and possible solutions to an error flagged in measurement mode.
Direction (Arrow) Keys	Move you through the structure diagram and subsequent menus and values. They may be used to increment one position at a time, or to move through a menu or string of values by holding a key in the depressed position.
ENTER Key	Enters the menu item or value selected.

Error Messages

The 870IT will display one of several messages when a problem occurs. These are summarized below:

Flashing Display: Occurs when there are not enough significant digits on the display to display a number. For example, if the PRIMARY SCALE was configured as 99.99 and a measurement of 100 was received, the display would flash +99.99.

CAL ERROR: Occurs when a limit condition was exceeded during an attempted calibration. CAL appears on the top line and ERROR on the bottom line of the display.

XMTR ER: Occurs in Measure mode only to indicate a transmitter problem. The transmitter is still configurable but measurements are held at the failsafe value if set.

PROBE ER: Occurs in Measure mode only when one of the following probe errors occurs: Glass, Lowslope, Coat, Leakage, Preamp, Aging, ATC Short, and ATC Open. For more information, see “Diagnostics” on page 15. Message appears on the bottom line of the display and flashes alternately with the bottom line measurement. The transmitter is still configurable. For probe errors of ATC Short or ATC Open, measurements are held at the temperature default value if set.

CONFIG ER: Occurs in Measure mode only when one of the following configuration errors occurs: Calibration Required, 4-20 Range, Measurement Range, and Compensation Range. For more information, see “Diagnostics” on page 15 Message appears on the bottom line of the display and flashes alternately with the bottom line measurement.

ER DATA: Occurs after you change a value and try to enter it with the ENTER key. Message appears on the bottom line of the display for 1 to 2 seconds and then automatically returns to the last legal value. The top line does not change from the previous edit prompt. Situations causing this message and appropriate responses are:

1. New value is out of range.
2. The slope of a chemical composition curve has changed sign.
3. The first value of a compensation point pair (TEMPx in TEMPCOMP or ABSx in CHEMCOMP) was entered that was not greater than the last one.

Passcode Access

Two levels of passcode protection are available. The Minor level permits access to Calibration and Output Hold. The Major level permits changing parameters in Configuration as well as access to Calibration and Output Hold. Both are 4-digit passcodes. The passcodes may or may not be the same. They are set as part of configuring the instrument.

Upon entering the Configuration, Calibration, or Hold mode by pressing the appropriate key, the display will read **PASSCODE 0000**. Upon entering the proper passcode and then pressing the **ENTER** key, the display will change to the next item in the appropriate structure. The initial factory default value for both Minor and Major passcodes is 0800.

Viewing and Changing Data

In the Configuration, Calibration, Hold, and Status modes, you will need to move through a structure of parameters (using the arrow keys and **ENTER** key) to view and/or change the value or status of a particular parameter. Structure diagrams, located in Appendix A, will aid you in doing this.

Note that the Up and Down arrow keys will scroll through a menu in either direction. Also, that the arrow keys may be used to increment one position at a time, or to move continuously through a menu or string of values by holding the key in the depressed position.

The following example will show you how to use the keys in moving through the structure. The example used is that of configuring temperature features. For the example, assume Fahrenheit temperature units, an automatic temperature mode, a default value of 77°F, and a 3-wire, 1000 ohm RTD. In following the procedure, refer to Figure 9.

1. Use the Right arrow key to move from **CONFIG TEMP** to **TEMP UNITS** and then to **UNITS CELSIUS**.
2. Use the Down arrow key to move to **UNITS FAHREN** and press the **ENTER** key. This will enter your Fahrenheit selection and move the display to **TEMP MODE**. Every temperature entry in the transmitter will now be in Fahrenheit units.
3. Use the Right arrow key to move to **MODE AUTO**. Press the **ENTER** key. This will enter your Auto selection and move the display to **DEFAULT 000.0**. The tenths digit will be flashing.
4. Because you do not need to change the tenths digit, use the Left arrow key to move to the units digit. Use the Up arrow key to change this digit to 7.
5. Use the Left arrow key to move to the tens digit and the Up arrow key to change this digit to 7. You have now achieved your goal of setting the value to 77.0, so press the **ENTER** key. This will enter your value of 77 and move the display to **TEMP TYPE**.
6. Use the Right arrow key to move to **TYPE RTD** and press the **ENTER** key. This will enter your selection of RTD and move the display to **RTD 2 WIRE**.
7. Use the Down arrow key to move to **RTD 3 WIRE** and press the **ENTER** key. This will enter your selection of 3 Wire and move the display to **3 WIRE 100 OHM**.
8. Use the Down arrow key to move to **1000 OHM** and press the **ENTER** key. This will enter your selection of 1000 ohm and move the display back to **CONFIG TEMP**. This completes the example.

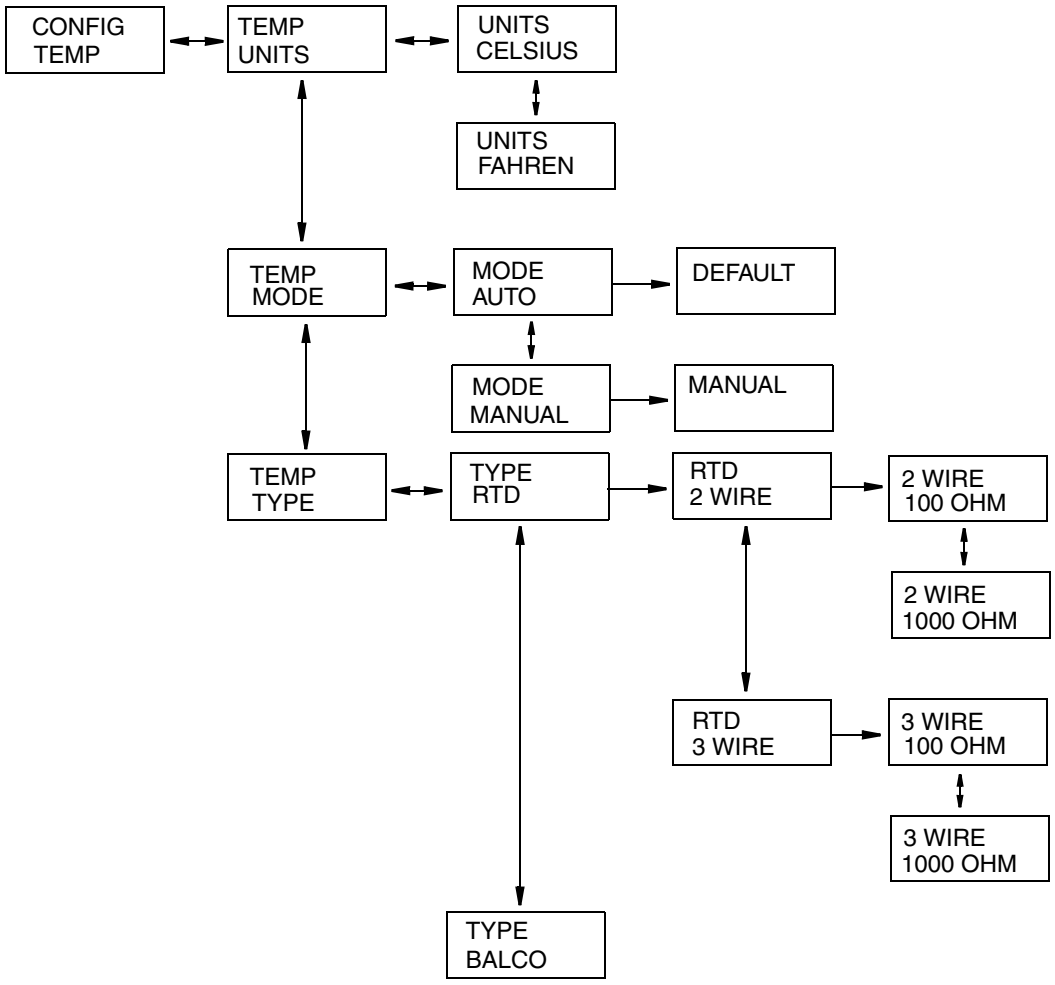


Figure 9. Example of Structure Diagram

Measure

Measure is the normal operating mode of your transmitter. The pH, ORP, or ISE measurement is shown on the top line of the display. Upon returning to Measure mode after changing many configuration parameters, the display may read **CONFIG ER**. This typically means that a calibration is required.

The second line of your display shows the absolute value of the sensor signal in millivolts, the output in 4 to 20 mA, or the temperature, depending on your configuration. You can view one of the other two selections by using the arrow keys. The display will return to the configured selection when the **TIMEOUT** time is reached. Transmitter (**XMTR ER**) and sensor (**PROBE ER**) errors are also shown on your display while in the Measurement mode.

Diagnostics

(Refer to “Structure Diagram 11” on page 48.)

The Diagnostics mode enables you to perform checks on your system at any point in time. While you are in the Diagnostic mode, two segments of the bar graph will appear under the legend **DIAG** at the top of the front panel. To enter the Diagnostics mode, press the **DIAG** key on the front panel. If there are no errors, your display will read **DIAGS OK**. If there was an error flagged as **XMTR ER**, **PROBE ER**, or **CONFIG ER** in the Measurement mode, the Diagnostics mode will help you further identify the specific error and corrective action. Possible errors and the recommended corrective actions are listed in Table 4.

Table 4. Diagnostic Error Messages

Message	Description	Corrective Action
Transmitter Error		
Probe Errors		
GLASS	Resistance of glass electrode is checked versus solution ground. Error is flagged if resistance is less than user set limit.	Replace electrode
LOWSLOPE	Flags an error after a 2-point calibration in buffers when the Nernst slope of the sensor becomes less than the user set limit.	Replace electrode or solution
COAT	Checks reference junction resistance against solution ground. Error is flagged if resistance is greater than user set limit.	Clean electrode
	Sensor is not immersed in solution.	Check that solution ground and reference junction are immersed in solution.
LEAKAGE	Checks solution leakage into the probe by checking resistance between solution ground and the RTD. Error is flagged if resistance is anything but infinite.	Replace
PREAMP	Checks preamplifier by monitoring voltage coming out of it. Error is flagged at voltage greater than 2 volts.	Replace
AGING	Flags an error after a 2-point calibration in pH buffers when the Nernst slope of the sensor has decreased sequentially five times.	See Note below
ATCSHORT ATC OPEN	Flags an error if the resistance of the temperature compensator is greater or less than the expected resistance of the device configured.	Replace temperature compensator

Table 4. Diagnostic Error Messages (Continued)

Message	Description	Corrective Action
Configuration Errors		
CAL REQ	Calibration required	Calibrate
4 - 20 RNG	Measurement outside configured range	Reconfigure range or correct process error
MEAS RNG	Measurement outside configured precision or scale	Reconfigure precision or correct process error
COMP RNG	Measurement outside compensation curve	Reconfigure compensation or correct process error

— NOTE

Corrective action for **AGING** error is to check the value of the slope in the Status menu. The glass or ISE electrode may be reaching the end of its useful life if the **SLOPE** differs greatly from the theoretical value (80% is usual limit but application requirements should dictate lowest acceptable slope).

Status

(Refer to “Structure Diagram 8” on page 45.)

The Status mode enables you to view the measurement and system parameters and thus assess the performance of the loop. You may **not** edit them in this mode. For a string display of more than eight characters, use the Left and Right arrow keys to scroll the display. All measurements (outputs) continue while in the Status mode. To enter the Status mode, press the **STATUS** key. Move through the menu by using the Up and Down arrow keys. While you are in the Status mode, two segments of the bar graph will appear under the legend **STATUS** at the top of your front panel. The Status menu contains the following parameters.

Table 5. Status Parameters

Parameter	Description
TEMP	Process Temperature
SLOPE	Efficiency of sensor expressed as the deviation in percent of the slope of the most recent calibration compared to the standard (e.g., mV/pH/59.16 mV/pH)
ABSOLUTE	Uncompensated millivolt signal from sensor [(a)]
mA	Analog Output: Analog output value in mA Digital Output: Output shown on secondary display in mA.
GLASSRES	Indicates whether resistance of glass electrode is acceptable
ASYMM	Asymmetry potential (mV difference from the expected theoretical isopotential pH voltage of zero)
REF RES	Resistance of reference electrode
ATC RES	Resistance of temperature compensator
CAL NAME	Name of last calibrator
LAST CAL	Date of last calibration (mm/dd/yy)

Table 5. Status Parameters (Continued)

Parameter	Description
TAG NUM	Tag number
TAG NAME	Tag name*
LOCATION	Location of measurement [b]
SONUMBER	Sales order number
MS CODE	Model code
S/W VER	Software version
DEV NAME	Device name*
DEV TYPE	Device type*

(a) See Table 12 for expected absolute mV readings. Absolute mV is a very useful sensor troubleshooting tool.

(b) Appears only on devices coded 870ITPH-F.

Configuration

Configuration is the process of enabling functional capability in the transmitter firmware for your application. This section will enable you to systematically determine and configure the value or status of each parameter required for your application. Many applications require only changing a few of the default values already entered. While you are in the Configuration mode, two segments of the bargraph will appear under the legend **CONFIG** at the top of your front panel. These segments will flash if you are also in a Hold mode. To enter the Configuration mode, press the **CONFIG** key. At the prompt, enter the four character Major passcode and press **ENTER**. If the passcode is correct, the display will flash **UNLOCKED** and then change to the first item in the configuration structure, **CONFIG DISPLAY**. You may then edit any of the parameters in the Configuration mode. If the passcode is incorrect, the display will flash **LOCKED** and then change to the first item in the configuration structure. You may view the parameters in this mode but will not have the ability to change them. In the **UNLOCKED** condition, the analog output defaults to 3.8 mA. If you do not want this to happen, turn the **HOLD** feature on first.

⚠ CAUTION

Always exit the Configuration mode by pressing the Measure key before power is turned off. This allows proper reinitialization of internal data base security checks.

Config Display

(Refer to “Structure Diagram 1” on page 38.)

This section of the structure enables you under **DISPLAY PRIMARY** to specify the **PRIMARY SENSOR** as pH, ISE, or ORP. This choice configures your analyzer as a pH, ORP or ion selective electrode transmitter. Only parameters pertinent to the specific measurement technology will appear in the configuration software after this initial choice is made. If pH, you can further specify the **PRIMARY RESOLUTION** as 0.1 or 0.01 pH. If ISE, you can further specify the **PRIMARY SCALE** as 9.999, 99.99, 999.9, or 9999 ppm. This choice specifies the largest value that may be displayed as well as the decimal placement in ppm.

NOTE

A change in the Primary Sensor, Resolution, or Scale requires a calibration.

Next, under **DISPLAY SECOND**, you can configure the secondary display to show the absolute value of the measurement in millivolts, the output in 4 to 20 mA, or the temperature.

Config Output

(Refer to "Structure Diagram 1" on page 38.)

This section of the structure first asks you to specify the **MODE**, referring to the communications and measurement output. If your transmitter was specified with analog output only (870ITPH-A), specify **ANALOG**. If your transmitter was specified with I/A Series communications (870ITPH-F), specify **ANALOG** if you want to have a 600 baud digital signal superimposed over an analog 4 to 20 mA signal, or specify **DIGITAL** if you want to have a 4800 baud digital signal only.

If you configured the mode as **ANALOG**, you will be asked, under **OUTPUT ANALOG**, to specify the 4 to 20 mA output to represent the uncompensated (**ABSOLUTE**) measurement, the temperature compensated **MEASURE**ment, or the **TEMP**erature.

If you configured the mode as **DIGITAL**, the 4 to 20 mA output will be fixed at 12 mA.

Next, under **OUTPUT RANGE**, enter the **MIN**imum (4 mA) and **MAX**imum (20 mA) range values for the output just specified. Specify between +2000 and -2000 mV for **ABSOLUTE**, in °C or °F for **TEMP**erature, or in measurement units (pH for pH, mV for ORP, ppm for ISE) for **MEASURE**. To configure the output as reverse acting, enter higher value as **MIN**imum and the smaller as **MAX**imum.

NOTE

1. 1. The units for temperature, °C or °F, are specified in the section titled "Config Temp" on page 20.
2. 2. A change in **OUTPUT ANALOG** will cause the **OUTPUT RANGE** to default to 0.0 and thus new **MIN** and **MAX** values must be entered.

Lastly, you can specify a fail-safe signal for all transmitter errors and for critical sensor diagnostic errors. Specify **ON** to specify a fixed output when in a failed condition. If **ON** is selected, further specify the **DC mA** output between 3.8 and 20.5 mA. The default value is 3.8 mA. If you want to have this signal outputted with ±0.5 mA pulse (as shown below) for greater visibility on a chart recorder or data display, specify **ON** as explained above and then go back and specify **PULSE**.

The **OFF** selection is not functional in the current versions of firmware. Any sensor diagnostic that has been set to **ENABLE** (see "Config Diags" on page 26) causes the output to go to the fail-safe **DC mA** signal. If sensor diagnostics are enabled, it is important to set the fail-safe **DC mA** value to an acceptable safe output level. If you do not want the output to respond to some or all of the sensor diagnostics, then you must set the selected diagnostics to **DISABLE** in the Config Diags menu.

Config Electrod

(Refer to "Structure Diagram 2" on page 39.)

— NOTE

This parameter will not appear if **ORP** was selected as **PRIMARY DISPLAY**.

This section of the structure asks you to specify the electrode:

- If measuring pH: Your choices are **GLASS**, **ANTIMONY**, or **OTHER**. **GLASS** sets the isopotential point at 7 pH. **ANTIMONY** sets it at 1 pH. **OTHER** allows the isopotential point to be set manually.
- If measuring ISE: You must specify the ion polarity. A positive ion selective measurement gets more positive (mV-wise) as the concentration increases (e.g., Na^+, K^+). A negative ion selective measurement gets more negative (mV-wise) as the concentration increases (e.g., F^-, S^{-2}). For fluoride measurements, this parameter should be set to negative.

— NOTE

A change in the electrode requires a calibration.

Config Tempcomp

(Refer to "Structure Diagram 2" on page 39.)

— NOTE

This parameter will not appear if **ORP** was selected as **PRIMARY DISPLAY**.

This section of the structure asks you to specify the temperature compensation if you are measuring pH or ISE.

If measuring pH, specify **STANDARD**, **AMMONIA**, or **CUSTOM**. **STANDARD** assumes a glass or antimony electrode and applies the Nernst equation. The nominal temperature compensation range is -5 to +105° C (23 to 221° F). **AMMONIA** compensates for traces of ammonia in addition to the standard compensation. **CUSTOM** allows you to specify particular solution characteristics into the transmitter's memory. When using this compensation, all measurements will be corrected back to a reference temperature measurement value. Therefore, you are asked to specify a reference temperature and a number of points to plot a compensation curve. The reference temperature (**REF TEMP**) should be within the nominal temperature compensation range. The number of points (**NUM PTS**) can be specified from 2 to 21 points and has a default value of 2. Each point specifies a value at a certain temperature. The temperatures (**TEMPx**) should be within the nominal temperature compensation range. The temperature units are specified in the next section. The values (**VALx**) can be specified from -2.00 to +16.00 pH and have a default of 0.00.

If **ISE** was chosen as your **PRIMARY DISPLAY**, you must specify **STANDARD** or **CUSTOM**. **CUSTOM** causes you to specify a reference temperature and a number of points to plot a compensation curve. The number of points (**NUM PTS**) can be specified from 2 to 21 points and has a default of 2. Each point specifies a value at a certain temperature. The temperature units are specified in the next section. The values (**VALx**) can be specified from 0 to 2000 ppm and have a default of 0.

For **CUSTOM** compensation, the temperature values must be entered in increasing order and the slope of the curve cannot change direction. Deviation from this requirement will cause an **ER DATA** message and force a resequence through the point pairs.

Config Temp

(Refer to "Structure Diagram 3" on page 40.)

This section of the structure asks you to specify the temperature features. First, specify the **TEMP UNITS** as **CELSIUS** or **FAHREN**heit. All references to temperature will appear in the specified units within the transmitter software.

Next, specify the **TEMP MODE** as **AUTO** or **MANUAL**. In the **AUTO** mode, the temperature follows the RTD. In **MANUAL** mode it is set at a fixed value. At this point you can set a **DEFAULT** value for the **AUTO** mode (in case the RTD fails) at the temperature at which you expect the process to be operating; or you can set a temperature for the **MANUAL** mode.

Last, specify the **TEMP TYPE** as standard **RTD** or **BALCO**. If you specify the **TYPE** as **RTD**, specify **2-WIRE** or **3-WIRE** and specify the resistance as **100 OHM** or **1000 OHM**. Follow Table 6 for Invensys Foxboro sensors.

Table 6. Invensys Foxboro Sensor Data

Sensor	Type	Resistance
PH10-..1 ORP10-..1	2-wire	100 Ω
PH10-..2 ORP10-..2	3-wire	1000 Ω
PH10-..3 ORP10-..3	2-wire	100 Ω
PH10-..4 ORP10-..4	3-wire	1000 Ω
871PH-1	2-wire	100 Ω
871PH-2	2-wire	100 Ω
871PH-3	3-wire	1000 Ω
871PH-4	3-wire	1000 Ω
871PH-5	2-wire	1000 Ω
871PH-6	2-wire	1000 Ω
871A-1	2-wire	100 Ω
871A-2	2-wire	100 Ω
871A-3	2-wire	1000 Ω
871A-4	3-wire	1000 Ω
EP459A	2-wire	100 Ω
EP460	3-wire	100 Ω
EP462	3-wire	100 Ω
EP466	3-wire	100 Ω

Config Damping

(Refer to "Structure Diagram 3" on page 40.)

This section of the structure asks you to specify the damping response time (90% of step). Choices are 1, 5, 10, 20, 40, and 120 seconds. Damping applies only to measurement data, not to temperature data.

Config Chemcomp

(Refer to "Structure Diagram 3" on page 40.)

If measuring ISE, this section of the structure asks you to specify the chemical compensation (**CHEMCOMP**) as **STANDARD** or **CUSTOM**. This is similar to what you did in "Config Tempcomp" on page 19. **CUSTOM** causes you to specify a number of points (**NUM PTS**) to plot a compensation curve. The number of points can be specified from 2 to 21 and has a default of 2 points. Each point specifies an absolute value (**ABSx**) and the value you want it to be (**NEWx**). The values can be specified from 0 to 2000 ppm and have a default of 0. The decimal point location for these values was determined as **PRIMARY SCALE** in **CONFIG DISPLAY**. The slope of the curve cannot change direction or be zero between any two points. Deviation from this requirement will cause an **ER DATA** message.

Config Instrmnt

(Refer to "Structure Diagram 4" on page 41.)

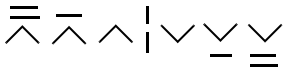
NOTE

This section is not displayed unless the correct passcode had been entered for Configuration.

INSTRMNT mA CAL

This subsection allows you to tune the 4 mA and 20 mA values. The procedure is as follows:

1. Connect a digital voltmeter to the to the calibration terminals (see Figure 7).
2. With **INSTRMNT mA CAL** displayed, press **ENTER**. The display will change to **mA CAL 4 mA**. Press **ENTER** again.
3. Calibration is performed by having your voltmeter read 100 mV. Do this by selecting one of the seven icons from the second line of your display by using the Left and Right arrow keys. When you have highlighted the icon you want, press **ENTER**. The icon meanings (shown below) are (from left to right) large increase, medium increase, small increase, accept and exit, small decrease, medium decrease, large decrease.



4. Repeat Step 3 until your meter reads 100 mV. Then highlight the center icon and press **ENTER**. The display will go to **mA CAL 20 mA**. Press **ENTER**.
5. Repeat the procedure shown in Steps 3 and 4 for 20 mA. The voltage reading should be 500 mV.

INSTRMNT STAB IND

When performing a calibration, the transmitter checks for stability in absolute measurement and temperature before accepting a change. This section enables you to configure the **TIME** allowed to attain stability and the amount of fluctuation (**VAR**) allowed. The value of **VAR** corresponds to the least significant digit of the measurement in the **PRIMARY DISPLAY** you configured in "Config Display" on page 17. For example, if you configured the **PRIMARY RESOLUTION** as 0.01 pH, then the value of **VAR** would be from 0.01 to 0.09 pH expressed as from 1 to 9. Both **TIME** and **VAR** are configured individually in **STAB IND MEAS**urement and **STAB IND TEMP**erature.

First, configure **STAB IND MEAS** as **ON** or **OFF**. If you configure this as **ON**, you need to specify the **TIME** between 5 and 60 seconds (in 5-second increments) and the **VAR**iable between 1 and 9. A longer time period and a smaller measurement value assures more stability during calibration. The default **TIME** is 5 seconds and the default **VAR**iable is 9. Thus, if the primary resolution was 0.01 and the default time and variable are used, the values can change at a rate of 0.09 pH over 5 seconds.

Then repeat the procedure for **STAB IND TEMP**. If you configure this as **ON**, you need to specify the **TIME** between 5 and 60 seconds (in 5-second increments) and the **VAR**iable between 1 and 9 (°C or °F). The default **TIME** is 5 seconds and the default **VAR**iable is 9.

Config Timeout

(Refer to "Structure Diagram 4" on page 41.)

This section of the structure asks you to specify the time in which the instrument will bring you back to the on-line/Measurement mode from another on-line mode (Status, Diagnostics, or the view only part of Configuration) when no keyboard input has occurred. In Measure mode, **TIMEOUT** also limits the time to view a secondary display other than that configured in **CONFIG DISPLAY**. The time may be specified between 0 and 999 seconds. A value of zero (0) disables the time-out function. The default time is 600 (10 minutes).

Config Buffers

(Refer to "Structure Diagram 5" on page 42.)

— NOTE

This parameter will not appear if **ISE** or **ORP** was selected as **PRIMARY DISPLAY**.

This section of the structure asks you to specify the buffers to be used if you are measuring pH and will use the Automatic Calibration feature described on page 31.

In Automatic Calibration, the pH value calculated with values from the last calibration is used to decide which buffer is in use. The algorithm checks each buffer starting with Buffer 1 and selects the first one for which this pH is within 0.5 pH of the average pH for the buffer. You may select between **AMERICAN**, **NIST**, **EUROPEAN**, and **SPECIAL** buffers as standard buffer table choices.

If you select **SPECIAL**, you must specify the number of points **(NUM PTS**) between 02 and 11 for Buffer 1, 2, and 3. The default value is 02. Each point specifies a value at a certain temperature. The temperatures **(TEMPx**) can be specified from -99.9 to +999.9 (°C or °F) and

have a default of 0.0. The values (**VALx**) can be specified from -2.00 to +16.00 pH and have a default of 0.00.

If the average pH values of two special buffers are less than 1 pH unit apart, using this procedure might result in the wrong buffer being selected. In this case, the buffer selection is based on the midpoint between the two buffers. It is not necessary to configure all three special buffers. If only two are used, they should be Buffers 1 and 2. If one is used, it should be Buffer 1. Enter Special buffer tables in the increasing order of the average pH for the buffer. The average pH is estimated as (first entry + last entry) / 2.

Tables of buffer values for nominal 4, 7, and 10 pH for American, NIST, and European buffers are listed below:

Table 7. American Buffer Tables

Temperature °C	4.00 pH	7.00 pH	10.01 pH
	pH Value	pH Value	pH Value
0	4.00	7.12	10.32
5	4.00	7.09	10.25
10	4.00	7.06	10.18
15	4.00	7.04	10.12
20	4.00	7.02	10.06
25	4.00	7.00	10.01
30	4.01	6.99	9.97
35	4.02	6.99	9.93
40	4.03	6.98	9.89
45	4.04	6.98	9.86
50	4.06	6.97	9.83

— NOTE

Values in Table 7 are based on common (nominal value) technical buffer systems. pH values are at 25°C. Chemical formulas are as follows:

4.00 pH: 0.05 molar Potassium Hydrogen Phthalate
7.00 pH: 0.041 molar Disodium Hydrogen Phosphate;
0.026 molar Potassium Dihydrogen Phosphate
10.01 pH: 0.025 molar Sodium Carbonate;
0.025 molar Sodium Bicarbonate

Table 8. NIST Buffer Tables

Temperature °C	4.01 pH	6.86 pH	9.18 pH
	pH Value	pH Value	pH Value
0	4.00	6.98	9.46
5	4.00	6.95	9.40
10	4.00	6.92	9.33

Table 8. NIST Buffer Tables (Continued)

Temperature ° C	4.01 pH	6.86 pH	9.18 pH
	pH Value	pH Value	pH Value
15	4.00	6.90	9.28
20	4.00	6.88	9.23
25	4.01	6.86	9.18
30	4.02	6.85	9.14
35	4.03	6.84	9.10
40	4.04	6.84	9.07
45	4.05	6.83	9.04
50	4.06	6.83	9.01

NOTE

Values in Table 8 are based on NIST Primary Buffer Systems. pH values are at 25°C. Chemical formulas are as follows:

4.01 pH: 0.05 molar Potassium Hydrogen Phthalate
6.86 pH: 0.025 molar Potassium Dihydrogen Phosphate;
0.025 molar Disodium Hydrogen Phosphate
9.18 pH: 0.01 molar Sodium Tetraborate Decahydrate (Borax)

Table 9. European Buffer Tables

Temperature ° C	4.61 pH	7.00 pH	9.21 pH
	pH Value	pH Value	pH Value
0		7.12	9.52
5		7.09	9.45
10	4.64	7.06	9.38
15	4.62	7.04	9.32
20	4.61	7.02	9.26
25	4.61	7.00	9.21
30	4.61	6.99	9.16
35	4.62	6.98	9.11
40	4.63	6.97	9.07
45	4.64	6.97	9.03
50	4.66	6.97	8.99
55	4.67	6.97	8.96
60	4.69	6.98	8.93
70	4.71	7.00	8.88
80		7.04	8.83
90		7.09	8.79
95		7.12	8.77

— NOTE

Values in Table 9 are based on commercially available technical buffers used in some parts of Europe. pH values are at 25°C. Chemical formulas are as follows:

4.61 pH: 0.1 molar Sodium Acetate; 0.1 molar Acetic Acid

7.00 pH: 0.026 molar Potassium Dihydrogen Phosphate;
0.041 molar Disodium Hydrogen Phosphate

9.21 pH: 0.05 molar Sodium Tetraborate Decahydrate (Borax)

Config Passcode

(Refer to “Structure Diagram 5” on page 42.)

— NOTE

This parameter is not displayed if the transmitter is locked (i.e., the correct passcode was not entered for Configuration).

This section of the structure asks you to specify the Minor and Major Passcode. The Minor passcode limits access to routine maintenance functions including **CALIBRATION** and output **HOLD**. The Major passcode prohibits unauthorized personnel from changing the configuration parameters. Each is a 4-character string between 0000 and 9999. They may or may not be the

same. The default passcodes are both 0800. To disable the passcode feature configure a passcode as 0000.

Config Strings

(Refer to “Structure Diagram 5” on page 42.)

This section of the structure asks you to specify the designation of the Tag Number (**TAG NUM**), Tag Name (**TAG NAME**), Location (**LOCATE**), and Device Name (**DEV NAME**). Each can be made up of characters from Table 10 and can be of up to the following number of characters in length:

TAG NUM	12
TAG NAME	14
LOCATE	14
DEV NAME	6

Only eight characters will be shown on your display at a time but the display will scroll as you enter additional characters.

— NOTE

Only **TAG NUM** appears if your transmitter was specified with analog output only (870ITPH-A).

Table 10. List of Characters

Characters
0 through 9
. (period)
–(dash)
(blank)
A through Z
_ (underscore)

Config AC Power

(Refer to “Structure Diagram 6” on page 43.)

This section of the structure asks you to specify, under **AC PWR**, the frequency that is used in your location. This information is used to eliminate interference in the **DIAG**nostic mode. If you specify 50 Hz, the transmitter performs its diagnostic tests using 60 Hz. If you specify 60 Hz, the diagnostics uses 50 Hz.

Config Diags

(Refer to “Structure Diagram 6” on page 43.)

This section of the structure allows configuring error messages that can appear on your display. You can elect to **ENABLE** all messages, **DISABLE** all messages or enable or disable each of the

following individually: **GLASS**, **LEAKAGE**, **LOWSLOPE**, **PREAMP**, **ATCSHORT**, **ATC OPEN**, **COAT**, **AGING**, **4-20 RNG**, **COMP RNG**, and **MEAS RNG**. Each of these is discussed below. A typical approach is to initially select **ENABLE ALLDIAGS** and to **DISABLE** select messages later when you find out that you do not require them. Further, when you have messages on your display, you may **CLEAR** all of the messages or **CLEAR** specific messages. This feature then disables the reporting of those messages for an hour to allow time for corrective maintenance.

— NOTE

Any sensor diagnostic that has been set to **ENABLE** causes the output to go to the fail-safe DC mA value when the diagnostic condition exists. Therefore, if sensor diagnostics are enabled, it is important to set the fail-safe **DC mA** value to an acceptable safe output level (see "Config Output" on page 18). If you do not want the output to respond to some or all of the sensor diagnostics, then you must set the selected diagnostics to **DISABLE**.

GLASS

This message reports a problem in the resistance of a glass electrode in the probe. Resistance of a glass electrode is checked versus solution ground. An error message appears if the resistance is less than user set limit. Besides clearing, enabling, and disabling the message, you can **LIMIT** the message to resistances below a set value. The **LIMIT** value may be set between 0 and 1100 kΩ in increments of 100 kΩ The default value is 500 kΩ You may also specify a **CUTOFF T**emperature above which this feature is disabled. **CUTOFF T** can be set between 0 and 100 (°C or °F). The default value is 50. The resistance of a glass bulb decreases (roughly is halved) for every 10°C increase in temperature.

— NOTE

Disable this message for ORP and ISE measurement.

LEAKAGE

This message reports a problem of liquid leakage into the sensor. The diagnostics checks the resistance between solution ground and the RTD. An error message appears if the resistance is anything but infinite. The message may be enabled, disabled, or cleared.

LOWSLOPE

This message reports a problem usually associated with an aging glass electrode. An error message appears after a 2-point calibration in buffer solutions when the Nernst slope of the sensor becomes less than the user set limit. The limit may be set between 0 and 100 percent. The default value is 80. The message may be enabled, disabled, or cleared.

— NOTE

Disable this message for ORP and ISE measurement.

PREAMP

This message reports a failed preamplifier. The diagnostics checks the preamplifier by monitoring the voltage coming out of it. An error message appears when the voltage is greater than 2 volts.

The message may be enabled, disabled, or cleared. The following Foxboro sensors contain a preamplifier: 871A-4, 871PH-3, 871PH-4, PH10-.P and ORP10-.P.

ATCSHORT, ATC OPEN

This message reports a problem if the resistance of the temperature compensator is greater or less than the expected resistance of the device configured. The message for each may be enabled, disabled, or cleared.

COAT

This message reports an increase in reference junction resistance. This can result from a fouled reference junction or if the electrode is not immersed in the process solution. The diagnostic checks the resistance against solution ground. An error message appears if the resistance is greater than the user set limit. The limit may be set between 0 and 100 kΩ in increments of 10 kΩ The default value is 80. The message may be enabled, disabled, or cleared.

— NOTE

1. During normal operation, this diagnostic may indicate that the pipe or tank has gone dry and the sensor is no longer in solution.
2. During sensor maintenance such as cleaning or calibration, this diagnostic may appear during the times the sensor is out of solution. When the sensor is again immersed, the diagnostic should turn itself off in a few minutes. If the diagnostic remains on, then the sensor should be treated as having a coating.

AGING

This message reports an aging glass electrode. An error message appears after a 2-point calibration in pH buffer solutions when the Nernst slope of the sensor has decreased sequentially five times. The message may be enabled, disabled, or cleared.

4-20 RNG

This message reports that the measurement that is tied to the analog output is outside the range that is configured for the application. The message may be enabled, disabled, or cleared.

COMP RNG

This message reports that the measured temperature or the absolute measurement is outside the temperature or chemical compensation curve that is configured for the application. The message may be enabled, disabled, or cleared.

MEAS RNG

This message reports that the measurement cannot be displayed accurately in the precision/scale that is configured for the application. The message may be enabled, disabled, or cleared.

Table 11 shows what diagnostics are available with various Foxboro sensors if enabled and configured with reasonable limits.

Table 11. Sensor Diagnostics

Sensor	Diagnostic[a]						
	Glass	Leakage	Lowslope	Preamp	Coat	Aging	ATC
PH10	X	X	X	X [b]	X	X	X
ORP10	X	X	X	X [b]	X	X	X
871PH-1 871PH-2			X			X	X
871PH-3 871PH-4	X	X	X	X	X	X	X
871PH-5 871PH-6	X	X	X		X	X	X
871A-1	X	X	X		X	X	X
871A-2			X			X	X
871A-3	X	X	X		X	X	X
871A-4	X	X	X	X	X	X	X
EP460-.N	X	X	X		X	X	X
EP460-.P			X			X	X
EP462	X	X	X		X	X	X
EP466	X	X	X		X	X	X

(a)X = applicable; blank = not applicable

(b)For PH10-.P or ORP10-.P.

Hold

(Refer to "Structure Diagram 7" on page 44.)

The Hold mode enables you to hold the output at a determined value, thus allowing you to configure or calibrate the transmitter or perform sensor maintenance without disturbing the control loop. If you do **not** put the transmitter in Hold mode before configuring or calibrating, the output will go to 4 mA if you have configured the output as **ANALOG** or it will be held at the present value if you have configured the output as **DIGITAL**.

While you are in the Hold mode, the bar graph will flash on and off. To enter the Hold mode, press the **HOLD** key. You will be prompted to enter the Minor Passcode. If you enter the incorrect passcode, the transmitter will revert to the Measurement (normal) mode. If you enter the correct passcode, the display will read **HOLD OFF** or **HOLD ON**. If it reads **HOLD OFF**, use the Down arrow key to change it to **HOLD ON**. Then specify whether you want to hold the output at the **PRESENT** value or at another value that you will **MANUAL**ly set.

If you selected **MANUAL** and your transmitter was specified with analog communications (870ITPH-A), your display will read **MANUAL ANALOG**. Specify the value between 4.00 and 20.00 mA at which you want to hold the output while in the Hold mode. The default value is 4.00.

If you selected **MANUAL** and your transmitter was specified with digital communications (870ITPH-F), and you had previously selected **ANALOG** under **CONFIG OUTPUT**, your display will read **MANUAL ANALOG**.

1. Specify the value between 4.00 and 20.00 mA at which you want to hold the output while in the Hold mode. The default value is 4.00.
2. Next, go to **MANUAL DIGITAL** and specify the **MEASURE**ment units, **TEMP**erature, and **ABSOLUTE** value at which you want to hold the output while in the Hold mode.
   a. The **TEMP**erature can be specified between -99.9 and +999.9 (°C or °F). The default value is 0.0.
   b. The **ABSOLUTE** value can be specified between -2000.0 and +2000.0 mV. The default value is 0.0.

If you selected **MANUAL** and your transmitter was specified with digital communications (870ITPH-F), and you had previously selected **DIGITAL** under **CONFIG OUTPUT**, your display will prompt you to specify the **MEASURE**ment units, **TEMP**erature, and **ABSOLUTE** value at which you want to hold the output while in the Hold mode.

1. The **TEMP**erature can be specified between -99.9 and +999.9 (°C or °F). The default value is 0.0.
2. The **ABSOLUTE** value can be specified between -2000.0 and +2000.0 mV. The default value is 0.0.

Calibration

(Refer to “Structure Diagram 9” on page 46 and “Structure Diagram 10” on page 47.)

Calibration routines in your transmitter were designed for simplicity and the elimination of user errors. The procedures are self-prompting. Two routines are available if you are measuring pH. A manual calibration enables you to enter or edit the value(s) of your solution. A single point or a 2-point manual calibration may be performed. However, a single point calibration may only be used if you have previously done a 2-point calibration with your sensor. An automatic calibration provides a buffer-recognition mechanism which locks in on the buffer value most closely representing the combination of millivolts and temperature values being reported from the sensor. Only manual calibration is available if you are measuring ORP or ISE. Only single point calibration is available if you are measuring ORP. Note that damping is not performed during either manual or automatic calibration.

— NOTE

Before doing any calibration, check that the temperature on the secondary display in the Measure mode agrees with the actual temperature of the solution. If there is a difference, the actual temperature should be entered under **CAL TEMP** in the Calibration mode before beginning your calibration. The temperature may be between -99.9 and + 999.9 (°C or °F).

While you are in the Calibration mode, two segments of the bar graph will appear under the legend **CAL** at the top of your front panel. These segments will flash if you are also in a Hold mode. To enter the Calibration mode, press the **CAL** key. You will be prompted to enter the Minor passcode. If you enter the incorrect passcode, the transmitter will revert to the

Measurement (normal) mode. If you enter the correct passcode, the display will read **CAL MANUAL**. If you need to adjust the temperature per the note above, go to **CAL TEMP** in the structure and enter the correct value. Then go back to either **CAL MANUAL** or to **CAL AUTO**.

If you are measuring ORP, instead of a **MANUAL SINGLEPT** calibration, you can use a **MANUAL ABSOLUTE** calibration. This is an internal calibration that rids the transmitter of nonapplicable calibration data. To do this, go from **MANUAL ABSOLUTE** to **PERFORM ABSOLUTE** and press **ENTER**.

If your diagnostics were configured to enable a **COAT** message, this message appears if the sensor is out of the solution for a sufficient period of time. This is a normal occurrence. The message disappears when you immerse your sensor.

— NOTE

Accurate calibration requires that the sensor and the standard solution must be stable at the same temperature. A less than optimum calibration results if either the sensor or the solution is changing temperature during the calibration procedure. For example, when a sensor is removed from a hot process, the sensor takes several minutes to cool to ambient temperature. Calibration should not be performed until the sensor has reached a stable temperature. You can monitor the temperature of the sensor in Status mode.

Manual Calibration

To perform a manual calibration (grab calibration):

1. Specify **SINGLEPT** or **TWO PT** calibration. **SINGLEPT** must be used for ORP.
2. Immerse your sensor in Solution 1 and press **ENTER**. If stability parameters were configured **ON**, the display **READING XXXXXXXX** will flash until stability is achieved and then alternate with the message **ENTER TO EDIT**. Wait for this message and then press **ENTER** again. If stability parameters were configured **OFF**, watch for the measurement to stabilize before proceeding to press **ENTER**.
3. If the reading is not correct, edit it to the correct value under **VALUE 1**. Press **ENTER**. Wait for a display of **CAL COMPLETE** (for **SINGLEPT**) or **IMMERSE IN SOL 2** (for **TWO PT**). If calibration was not successfully completed, the display will read **CAL ERROR** and return you to **MANUAL SINGLEPT** or **MANUAL TWO PT**.
4. If you are doing a 2-point calibration, place the sensor in the second solution and repeat the procedure. Upon completion a display of **CAL COMPLETE** will appear.
5. Press **MEASURE** to return to Measurement mode.

— NOTE

A manual calibration of the transmitter without its sensor can also be done with theoretical millivolt inputs. See “Electronic Calibration” below.

Automatic Calibration

In Automatic Calibration, the pH value is first measured with the last calibration constants entered to decide which buffer is in use. The algorithm checks each buffer starting with Buffer 1

and selects the first one for which this pH is within 0.5 pH of the average pH for the buffer. If this pH is not within 0.5 pH unit of any buffer table, a **CAL ERROR** message is displayed and no buffer is selected.

To perform an automatic calibration:

1. Press **ENTER** at the prompt **CAL AUTO**.
2. At the prompt **IMMERSE IN BUF 1**, immerse your sensor in the first buffer solution and press **ENTER** after you have done so.
3. If stability parameters were configured **ON**, the display **READING XX.XX** pH will flash until stability is achieved and then alternate with the message **ENTER TO CONTINUE**. Wait for this message and then press ENTER again. If stability parameters were configured **OFF**, watch for the measurement to stabilize before proceeding to press **ENTER**. The instrument will then find the nearest buffer value and display that value on the display under the heading BUF 1 IS. Press **ENTER** if acceptable.
4. Wait for the first calibration to be completed. At the prompt **IMMERSE IN BUF 2**, immerse your sensor in the second solution and repeat the procedure just completed for **BUF 1**. Completion will be indicated with the display **CAL COMPLETE**.

Documentation of Calibration Procedure

Next, optionally follow the prompts to enter the calibration date, and name of the calibrator. The date should be in the form mm/dd/yy. The name of the calibrator can contain up to six characters.

NOTE

Invensys Foxboro recommends keeping a record of your calibrations. Recording the mV values and slope can help you establish maintenance and replacement information on your sensors. See Table 12 to calculate the expected mV value generated by a sensor in contact with a buffer of known pH value. Slope and mV values together provide useful data for troubleshooting the pH sensor.

Electronic Calibration

This calibration procedure can be used to verify the calibration of the transmitter. It is not required at startup or for routine sensor/transmitter loop calibration. This procedure is recommended for troubleshooting a measurement loop to isolate a problem to the transmitter or eliminate the transmitter as a source of a problem. A millivolt source is used to supply theoretical millivolt inputs in place of the sensor.

1. Disconnect all sensor leads from your transmitter.
2. Connect a millivolt source between sensor input terminals as follows: positive to terminal 3 and negative to terminal 4. Jumper terminals 4 and 5.
3. In Configuration mode, go to **CONFIG TEMP** and set the temperature in **MANUAL** to 25°C or 77°F.
4. Go to Calibration mode. In **CAL MANUAL**, specify **SINGLEPT** or **TWO PT** calibration. **SINGLEPT** must be used for ORP.

5. Adjust the millivolt supply to your first value as determined by the formula in Table 12 and press **ENTER**. Wait for the display **READING XXXXXXXX** to alternate with the message **ENTER TO EDIT** and then press **ENTER** again.

Table 12. Millivolt Supply Formulas

Measurement Mode	mV Power Supply Formula	Examples
Glass pH	(pH-7)x (-59.16)	pH0: (0-7) x (-59.16) = +414.1 mV pH14: (14-7) x (-59.16) = -414.1 mV
Antimony pH	(pH-1)x (-55)	pH0: (0-1) x (-55.00) = +55.0 mV pH7: (7-1) x (-55.00) = -330.0 mV
ORP	(mV)	Input absolute millivolt
ISE	-59 x log (expected F^- in ppm) + 118 mV	Fluoride (F^-) Charge is negative and monovalent (n=-1) Typical mV values: 1 ppm: (-59)log(1) +118 = 118 mV 2 ppm: (-59)log(2) +118 = 100 mV 10 ppm: (-59)log(10) = 118 = 59 mV 100 ppm: (-59)log(100) +118 = 0 mV

6. If the reading is not correct, enter the correct value under **VALUE 1**. Press **ENTER**. Wait for a display of **CAL COMPLETE** (for **SINGLEPT**) or **IMMERSE IN SOL 2** (for **TWO PT**). If calibration was not successfully completed, The display will read **CAL ERROR** and return you to **MANUAL SINGLEPT** or **MANUAL TWO PT**.
7. If you are doing a 2-point calibration, adjust the millivolt supply to the second value and repeat the procedure.
8. Go to Measure mode. Adjust the millivolt source to a known value between the calibration points and verify the measurement as displayed on the transmitter per Table 12.
9. Go to Configuration mode to reset the temperature to **AUTO** or desired **MANUAL** setting as necessary.
10. Lastly, reconnect your sensor wires to the transmitter.

4. Maintenance

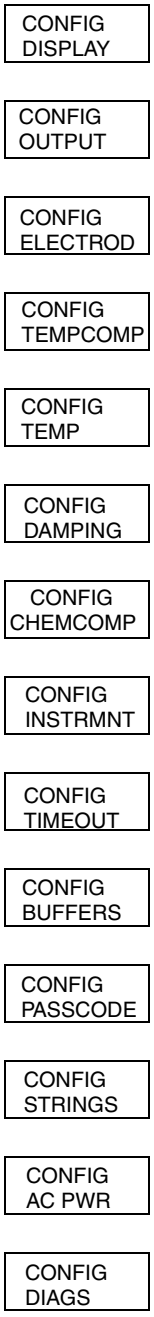
⚠ WARNING

This product contains components that have critical safety characteristics. **Do not** substitute components. Replace components only with identical factory supplied components. Component substitution may impair the electrical safety of this equipment and its suitability for use in hazardous locations.

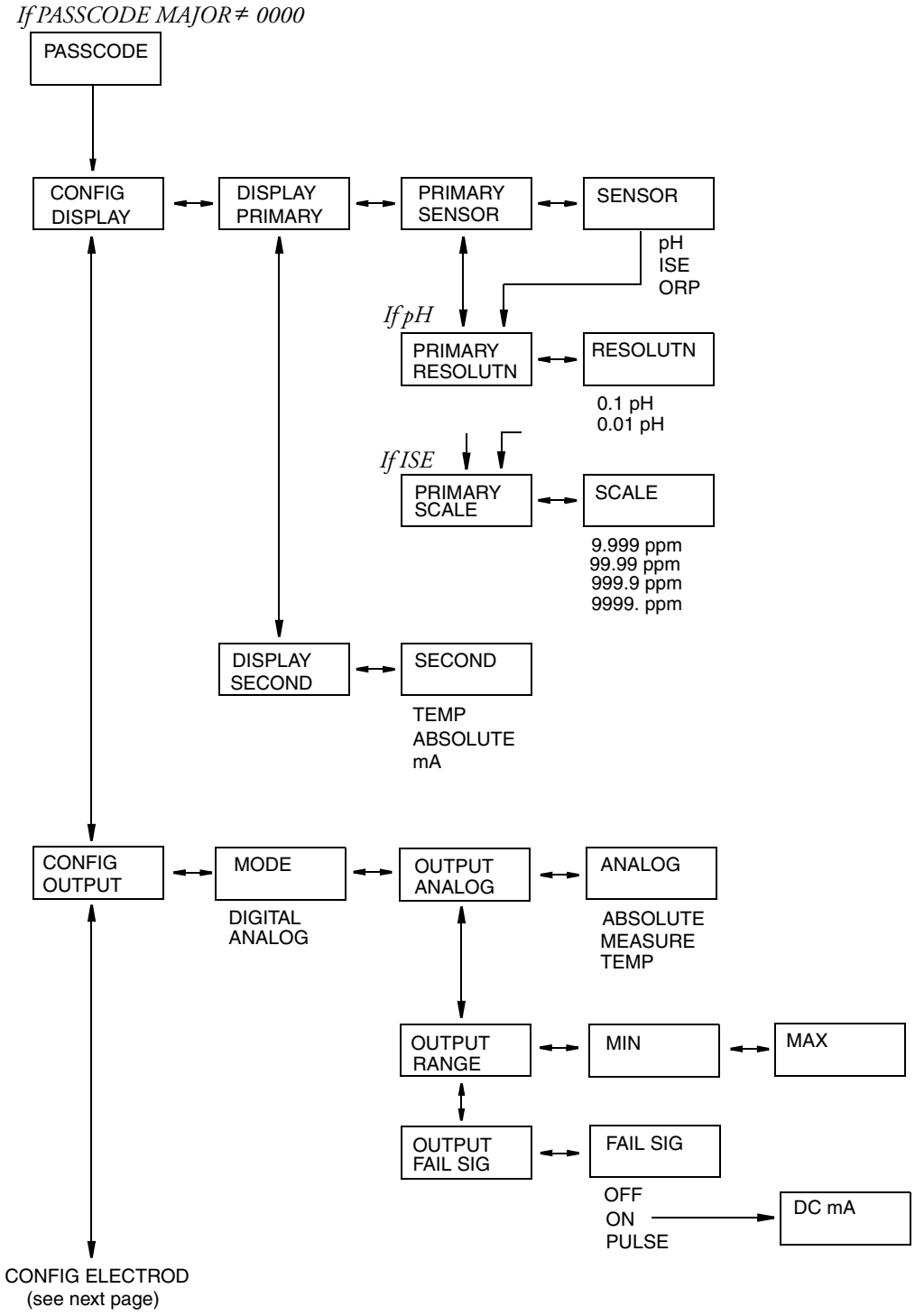
The maintenance of the 870IT Transmitter is limited to replacement of the keypad, the core printed wiring assembly (PWA), and the sensor PWA. See PL 611-156 for Style A or PL 611-153 for Style B transmitter part numbers. Attempts to repair printed wiring assemblies could result in damage and voiding of the warranty. The recommended repair procedure is replacement of the PWA or return of the PWA to the factory for repair.

Appendix A. Structure Diagrams

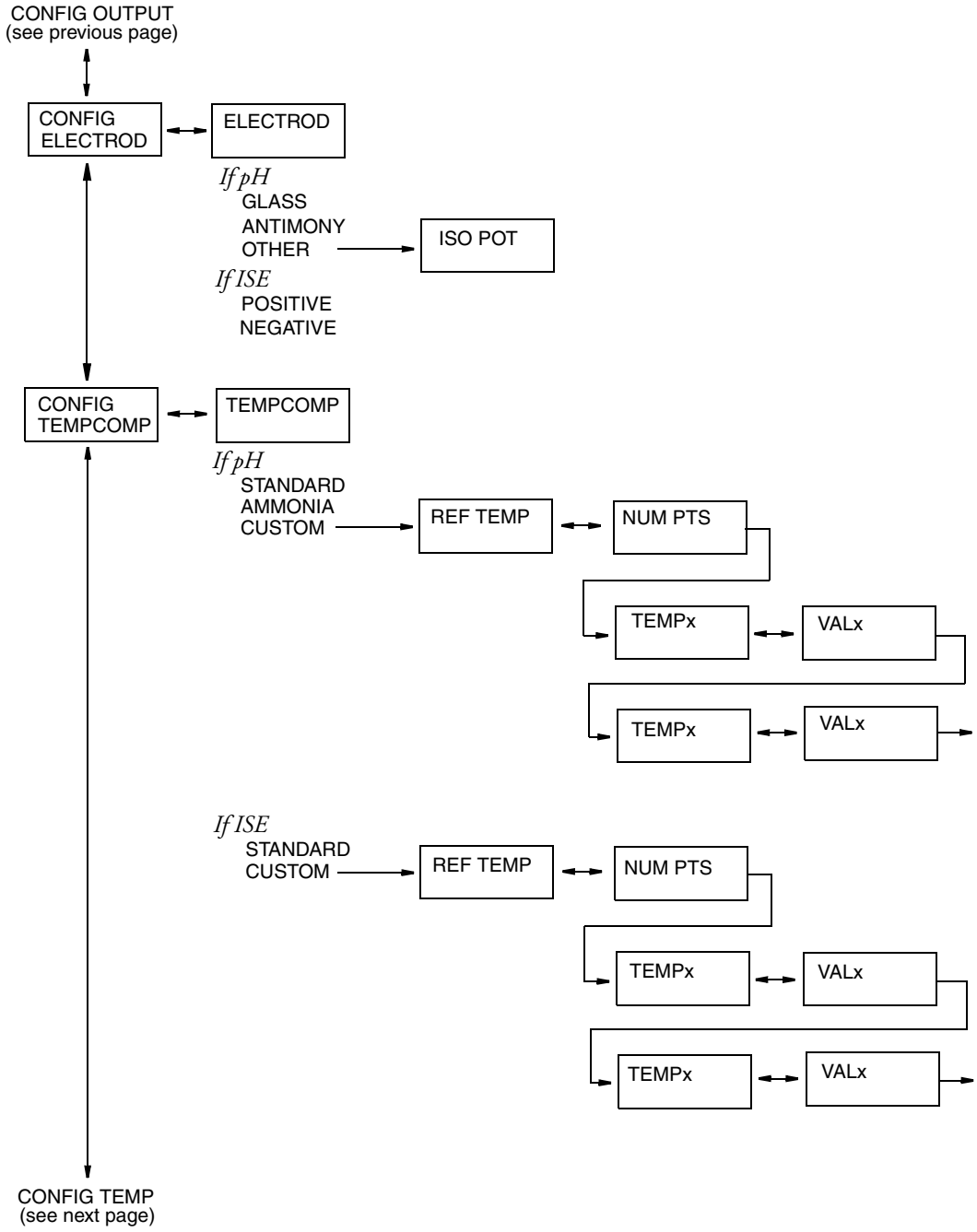
Top Level Structure Diagram



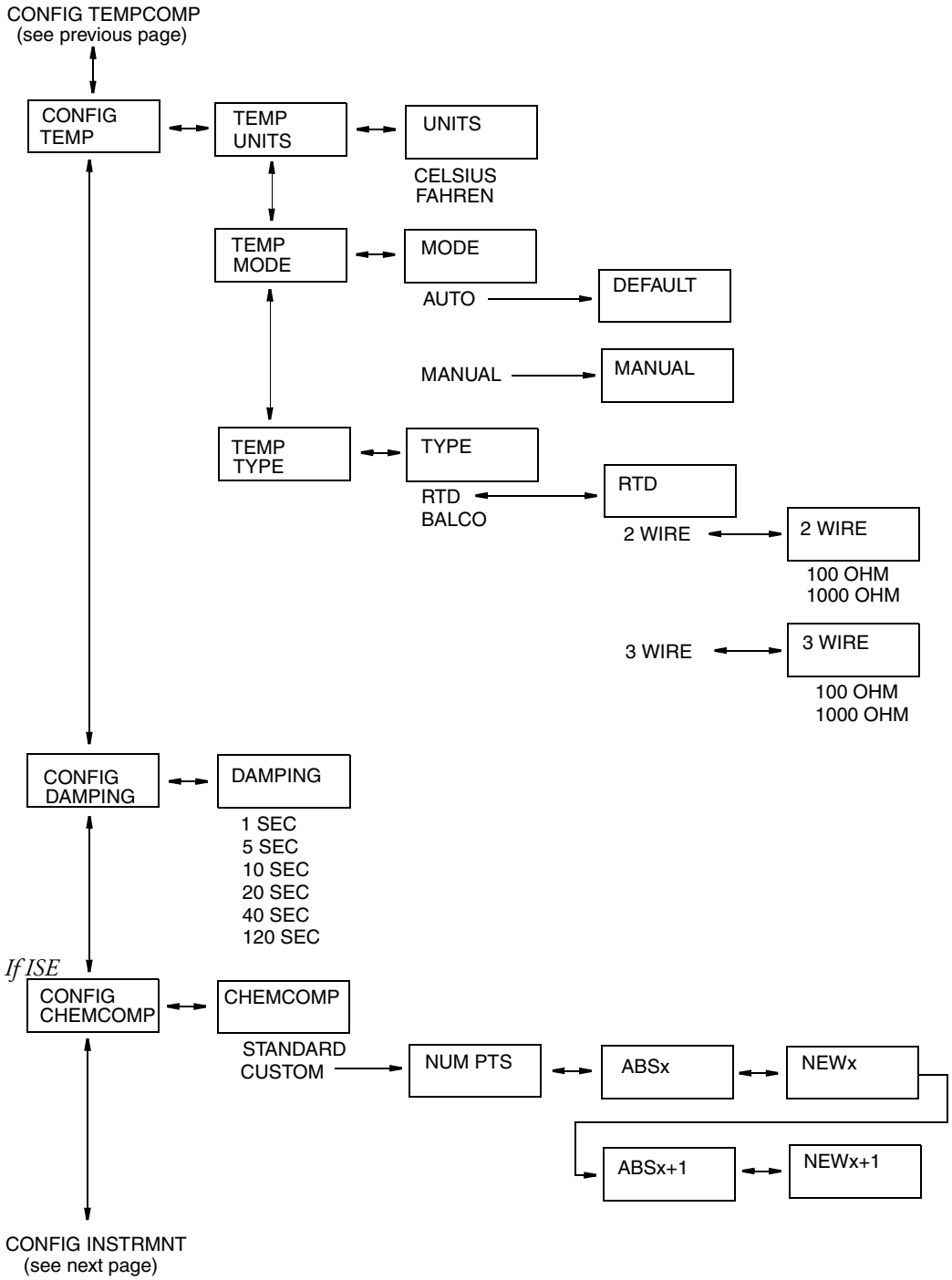
Structure Diagram 1
CONFIGURATION



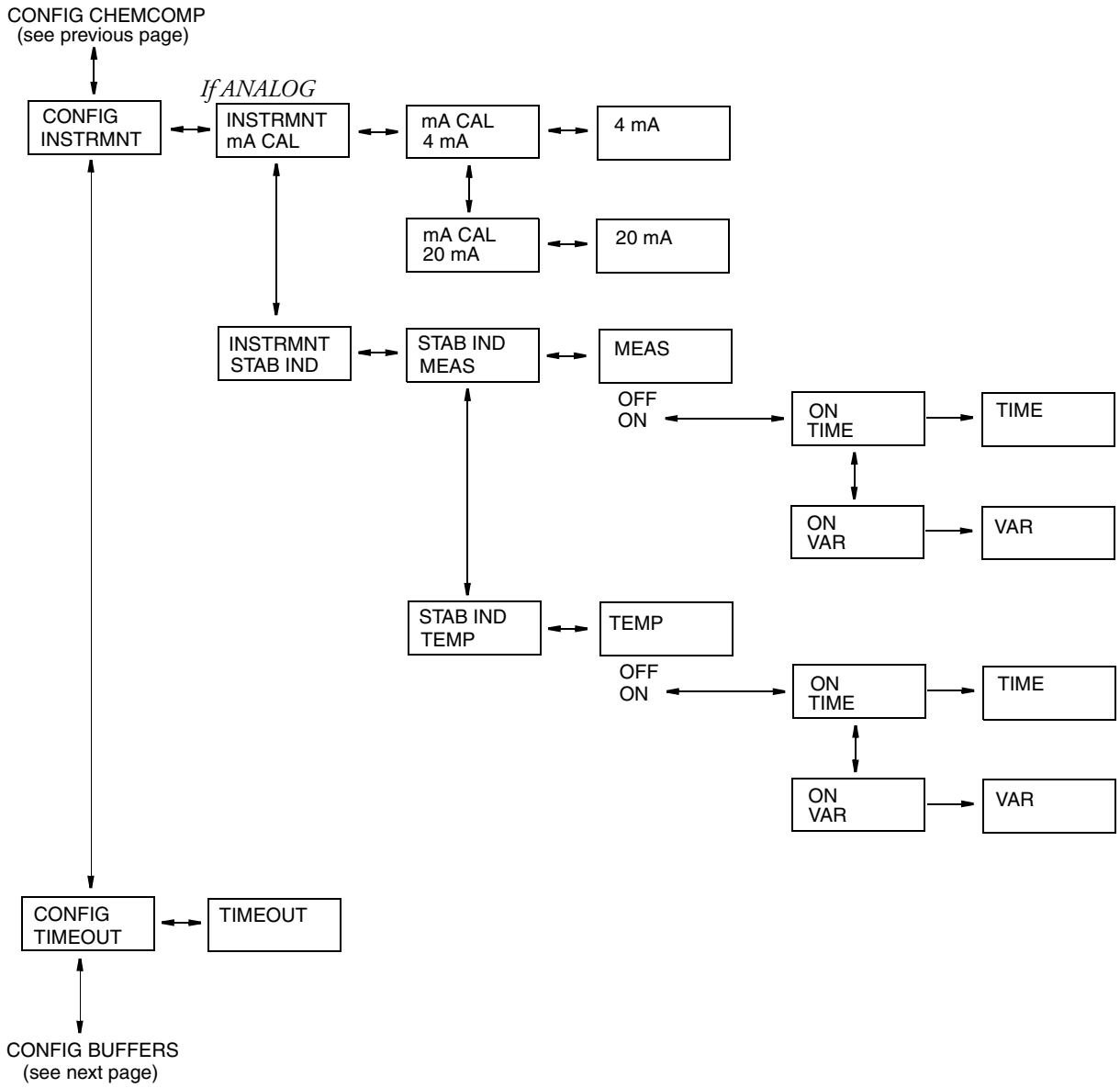
Structure Diagram 2
CONFIGURATION (cont.)



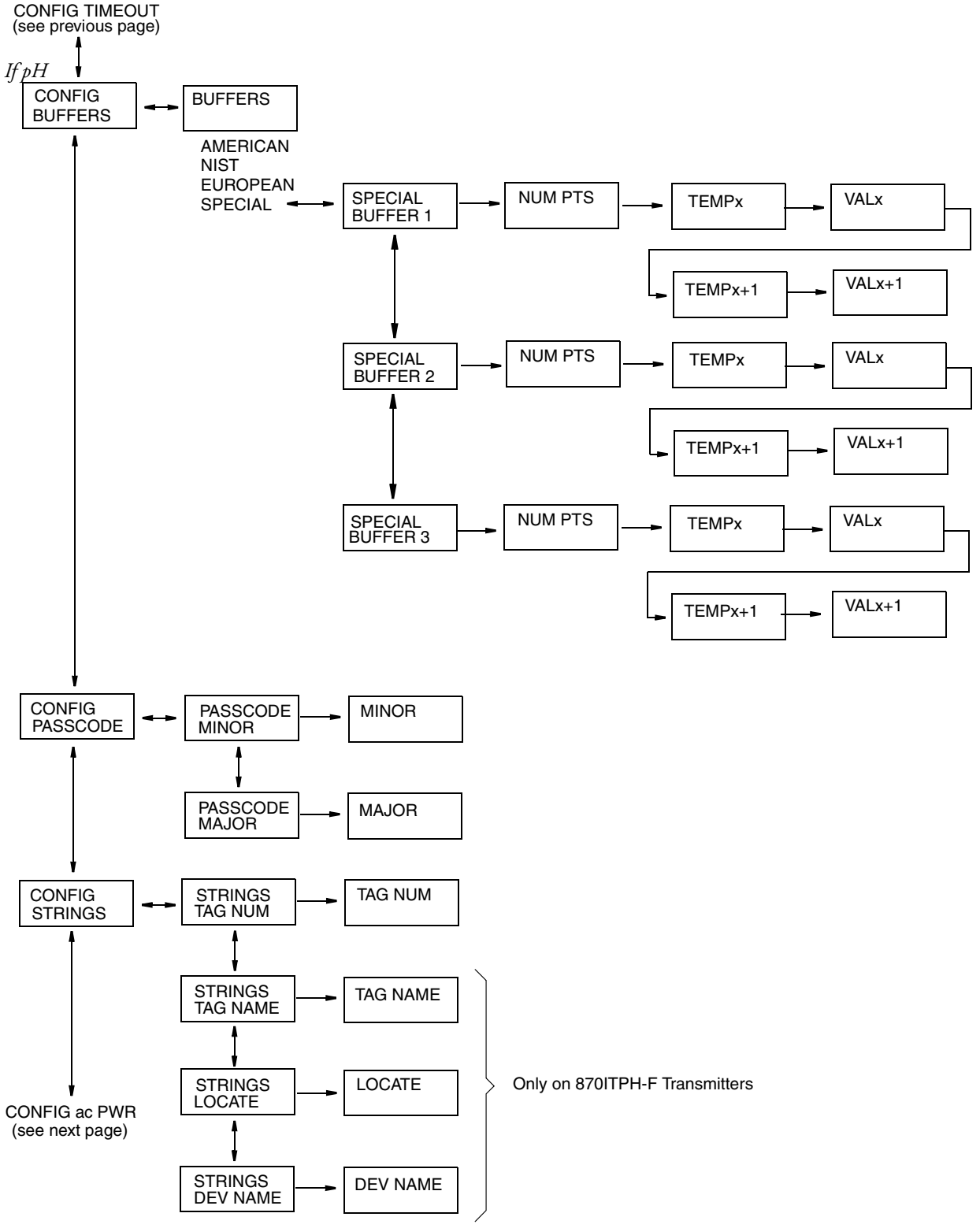
Structure Diagram 3
CONFIGURATION (cont.)



Structure Diagram 4
CONFIGURATION (cont.)

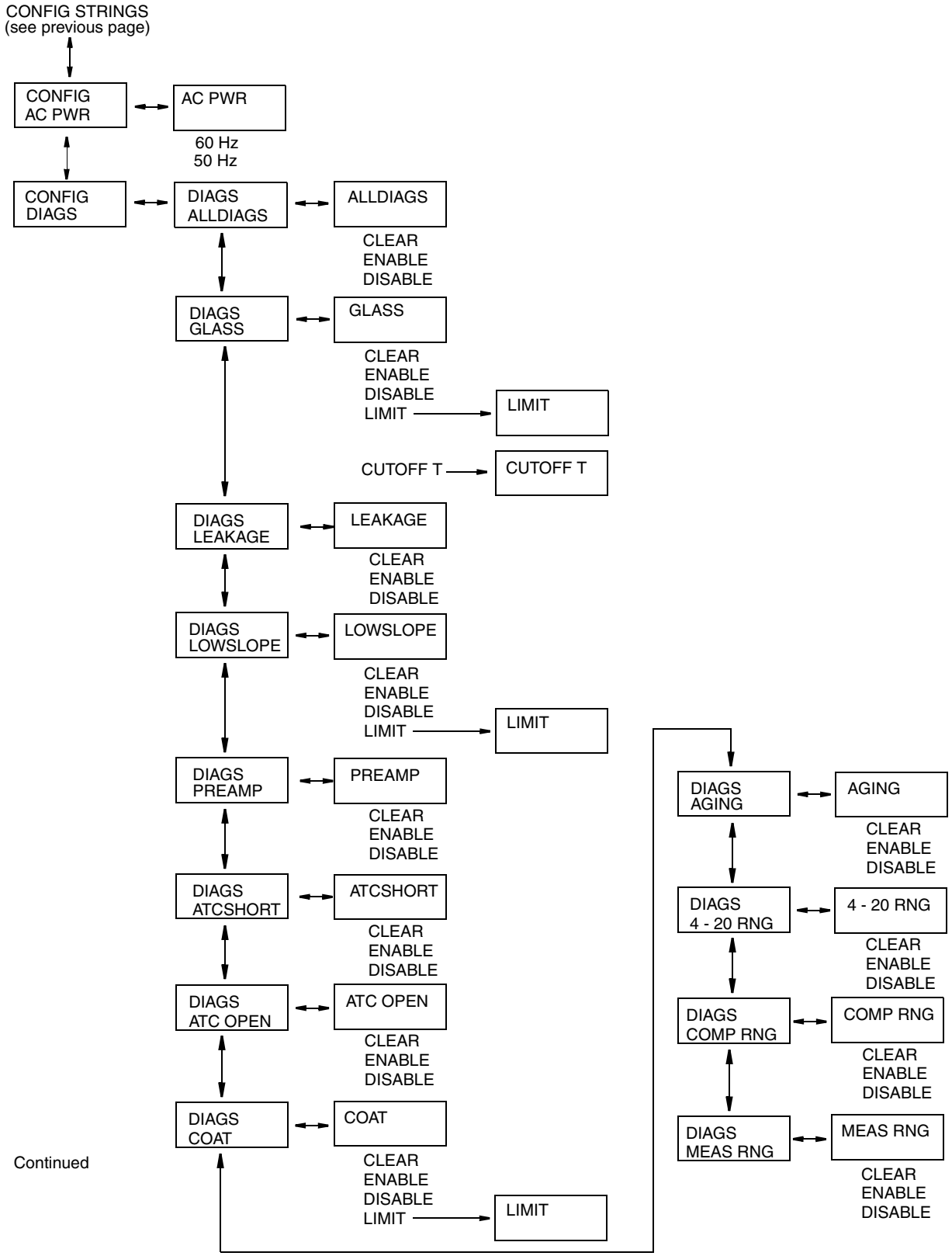


Structure Diagram 5
CONFIGURATION (cont.)



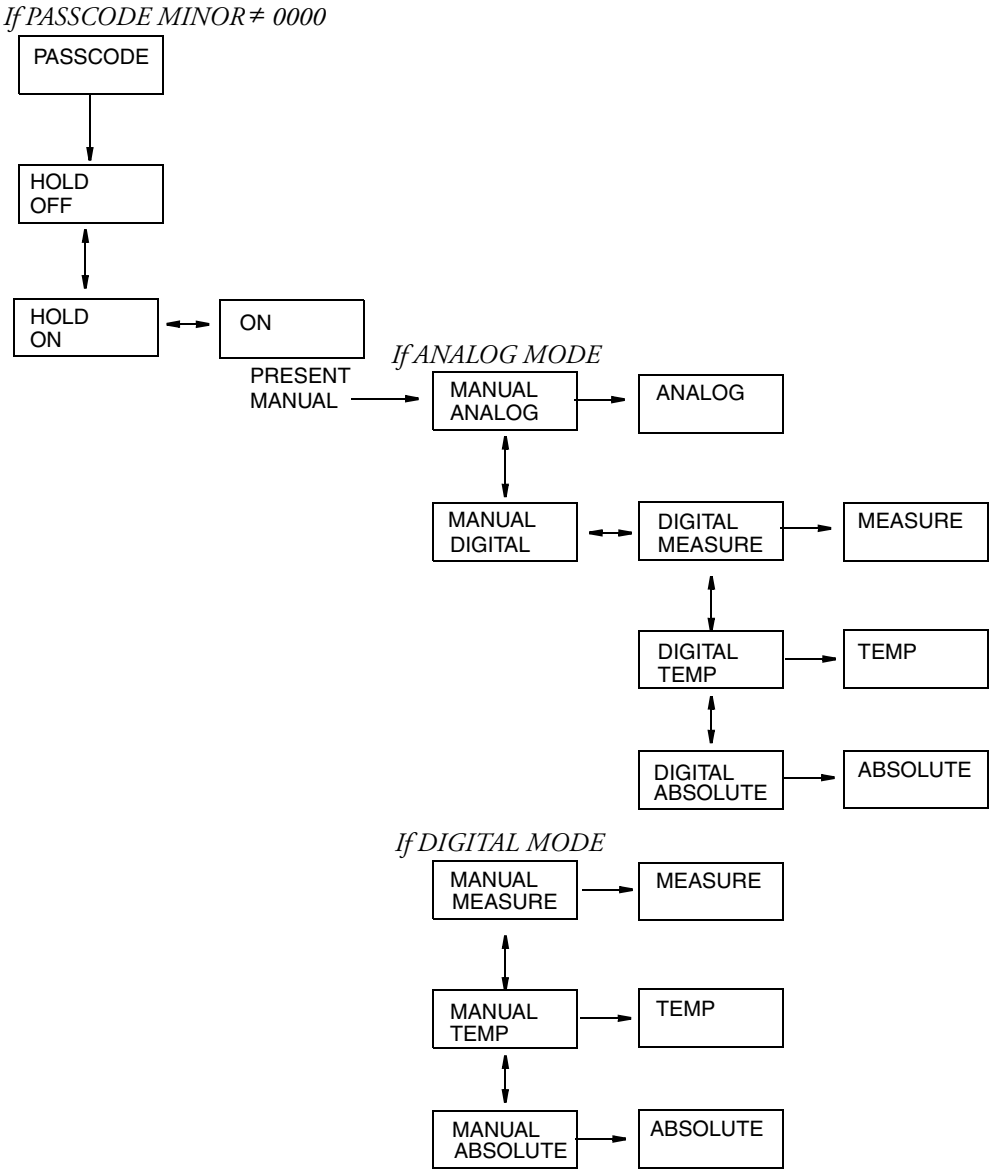
Structure Diagram 6

CONFIGURATION (cont.)

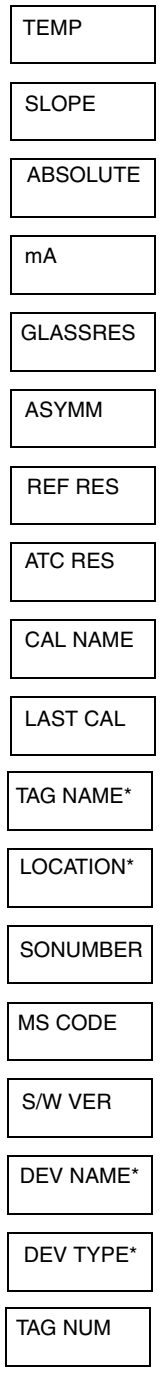


Structure Diagram 7

HOLD



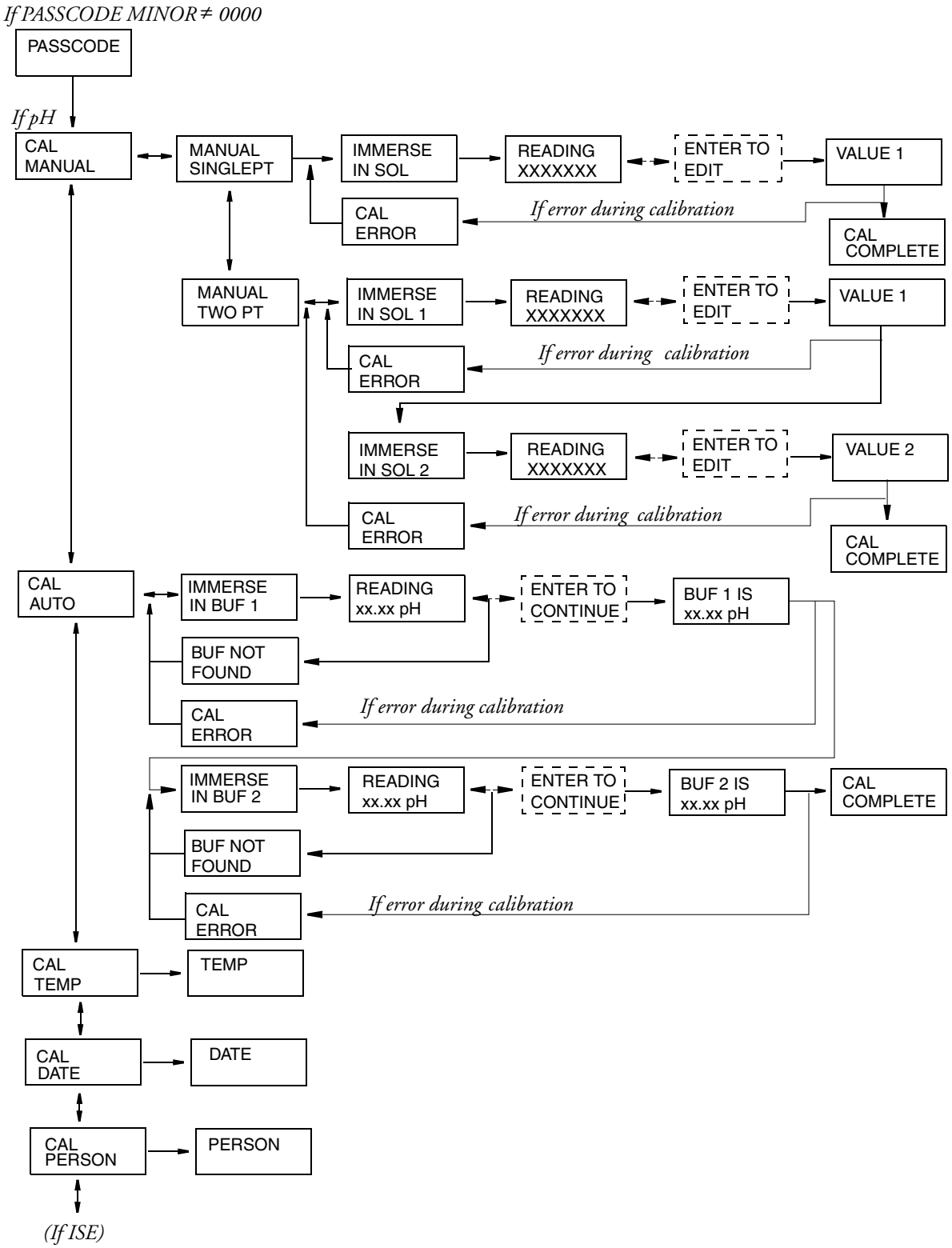
Structure Diagram 8
STATUS



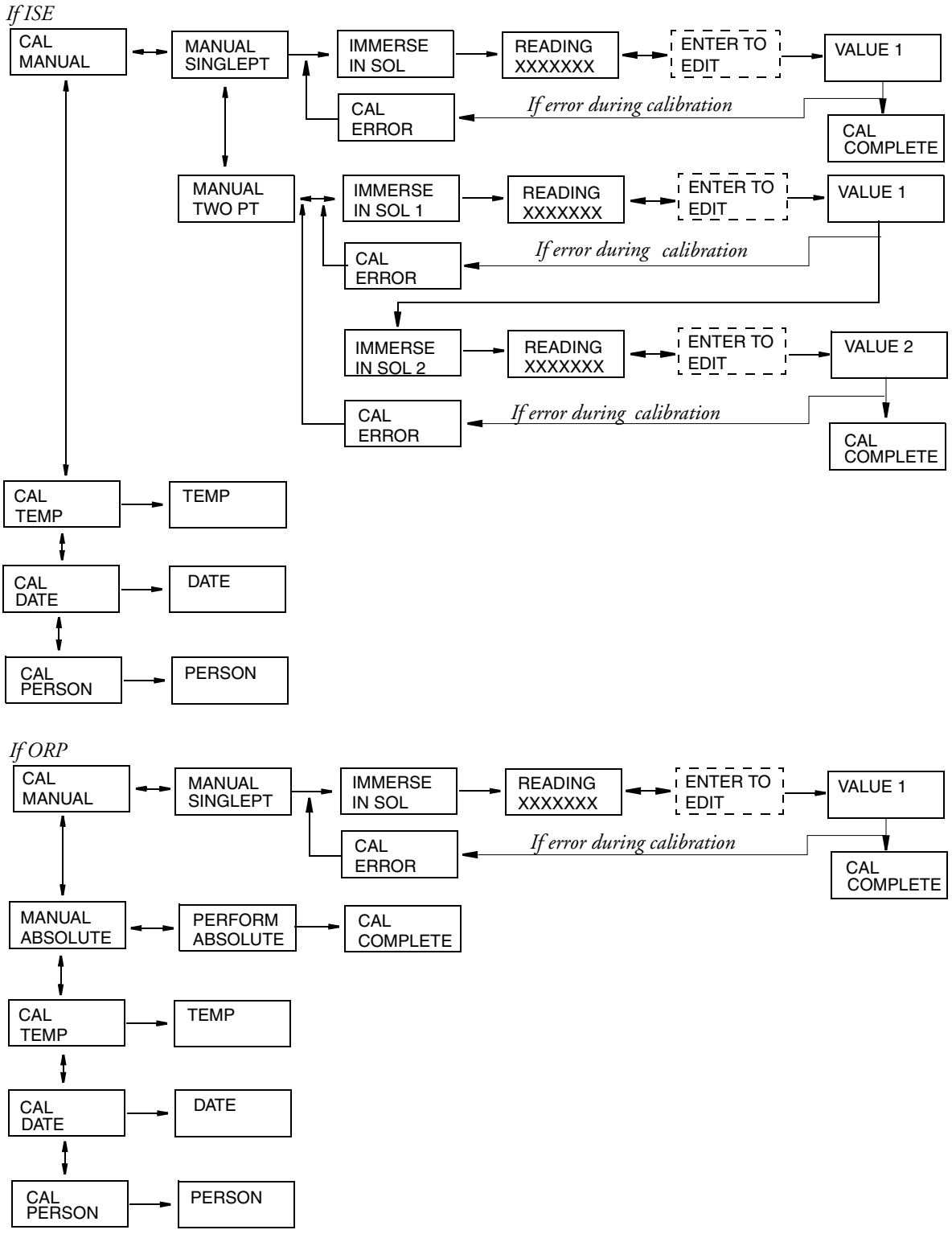
* Appears only on devices coded 870ITPH-F

Structure Diagram 9

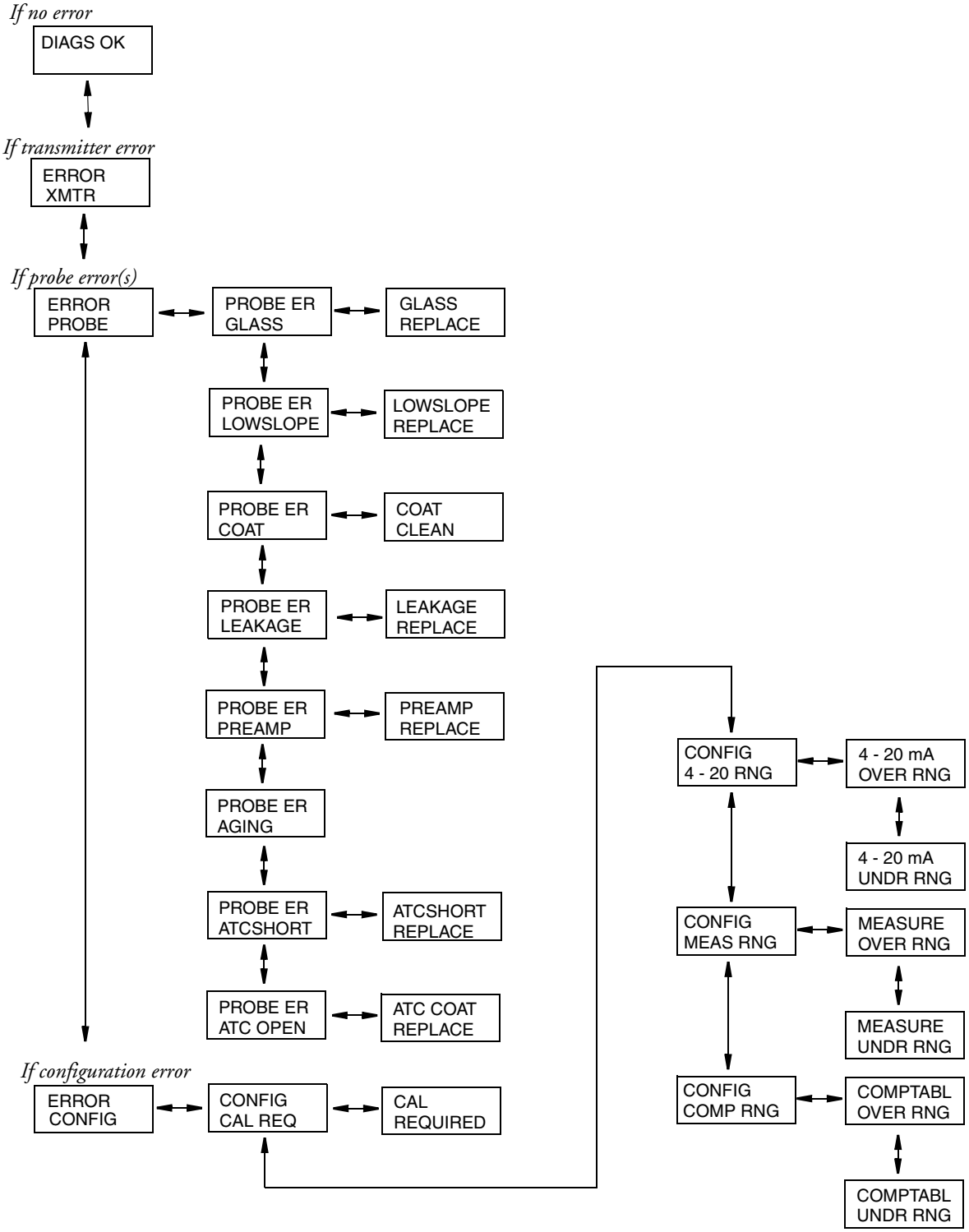
CALIBRATION



Structure Diagram 10
CALIBRATION (cont.)

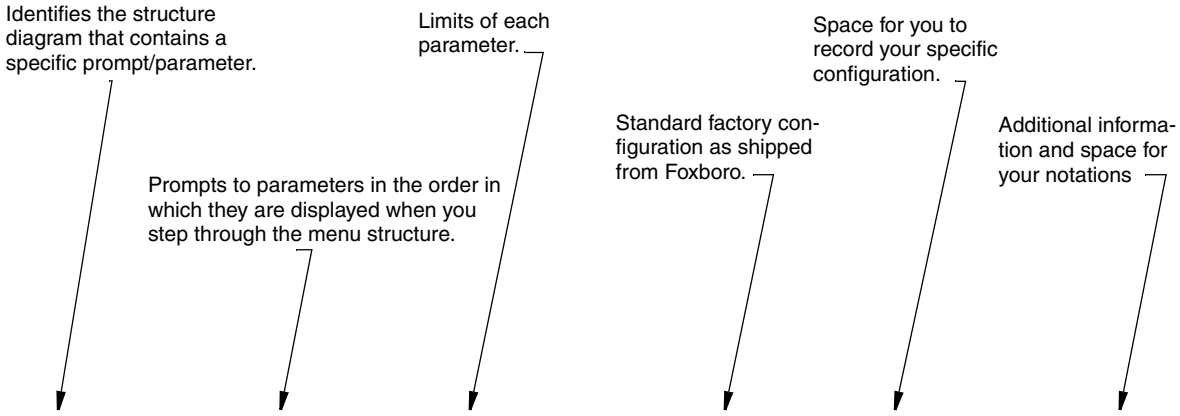


Structure Diagram 11
DIAGNOSTICS



Appendix B. Configuration Table

This appendix contains information that will help you configure your transmitter. The information is presented in the form of a table containing each prompt/parameter, its limits, and its factory default value. It also provides space for you to record your specific configuration and notations.


Identifies the structure diagram that contains a specific prompt/parameter.
Limits of each parameter.
Space for you to record your specific configuration.
Standard factory configuration as shipped from Foxboro.
Additional information and space for your notations
Prompts to parameters in the order in which they are displayed when you step through the menu structure.

Structure Diagram	Prompt/Parameter	Parameter Limits	Factory Configuration	User Configuration	Remarks and Notes
1	PASSCODE	0001 AND 9999	0800		If PASSCODE MAJOR ≠ 0000
	CONFIG DISPLAY	- - -			
	DISPLAY PRIMARY	- - -			
	PRIMARY SENSOR	- - -			
	SENSOR	pH, ISE, ORP	pH		
	PRIMARY RESOLUTN	- - -			If pH
	RESOLUTN	0.1, 0.01 pH	0.01 pH		
	PRIMARY SCALE	- - -			If ISE
	SCALE	9.999, 99.99, 999.9, 9999 ppm			
	DISPLAY SECOND	- - -			
	SECOND	TEMP, ABSOLUTE, mA	TEMP		
	CONFIG OUTPUT	- - -			
	MODE	ANALOG, DIGITAL	ANALOG		
	OUTPUT ANALOG	- - -			If ANALOG
	ANALOG	ABSOLUTE, MEASURE, TEMP	MEASURE		
	OUTPUT RANGE	- - -			

Structure Diagram	Prompt/Parameter	Parameter Limits	Factory Configuration	User Configuration	Remarks and Notes
1	MIN	Depends on Analog Output	0 pH		
	MAX		14 pH		
	OUTPUT FAIL SIG	- - -			
	FAIL SIG	OFF, ON, PULSE	OFF		
	DC mA	3.8 and 20.5 mA	3.8		If FAIL SIG = ON
2	CONFIG ELECTROD	- - -			
	ELECTROD	GLASS, ANTIMONY, OTHER	GLASS		If pH
		POSITIVE, NEGATIVE			If ISE
	CONFIG TEMPCOMP				
	TEMPCOMP	STANDARD, AMMONIA, CUSTOM	STANDARD		If pH
	(CUSTOM)	- - -			
	REF TEMP	-99.9 and 999.9	0.0		°C or °F
	NUM PTS	02 and 21	02		
	TEMPx	-99.9 and 999.9	0.0		°C or °F
	VALx	-2.00 and +14.00 pH	0.00		
	TEMPCOMP	STANDARD, CUSTOM			If ISE
	(CUSTOM)	- - -			
	REF TEMP	-99.9 and 999.9			°C or °F
	NUM PTS	02 and 21			
	TEMPx	-99.9 and 999.9			°C or °F
	VALx	0 AND 2000 ppm			

Structure Diagram	Prompt/Parameter	Parameter Limits	Factory Configuration	User Configuration	Remarks and Notes
3	CONFIG TEMP	- - -			
	TEMP UNITS	- - -			
	UNITS	CELSIUS, FAHREN	CELSIUS		
	TEMP MODE	- - -			
	MODE	AUTO, MANUAL	AUTO		
	DEFAULT	-99.9 and 999.9			If AUTO
	MANUAL	-99.9 and 999.9			If MANUAL
	TEMP TYPE	- --			
	TYPE	RTD, BALCO 3K	RTD		
	RTD	2 WIRE, 3 WIRE	3 WIRE		If RTD
	2 WIRE	100 OHM, 1000 OHM			If 2 WIRE
	3 WIRE	100 OHM, 1000 OHM	1000 OHM		If 3 WIRE
	CONFIG DAMPING	- - -			
	DAMPING	1, 5, 10, 20, 40, or 200	5		SECond
	CONFIG CHEMCOMP	- - -			If ISE
	CHEMCOMP	STANDARD, CUSTOM	STANDARD		
	(CUSTOM)	- - -			
	NUM PTS	02 and 21	02		
	ABSx	0 and 9999 ppm			
	NEWx	0 and 9999 ppm			
4	CONFIG INSTRMNT	- - -			
	INSTRMNT mA CAL	- - -			
	mA CAL 4 mA				
	4 mA				
	mA CAL 20 mA				
	20 mA				

Structure Diagram	Prompt/Parameter	Parameter Limits	Factory Configuration	User Configuration	Remarks and Notes
4	INSTRMNT STAB IND	- - -			
	STAB IND MEAS	- - -			
	MEAS	ON, OFF	ON		
	ON TIME				If ON
	TIME	5 - 60	5		Increments of 5 s
	ON VAR				
	VAR	1 and 9	9		
	STAB IND TEMP	- - -			
	TEMP	ON, OFF	ON		
	ON TIME				
	TIME	5 - 60	5		Increments of 5 s
	ON VAR				
	VAR	1 and 9	9		
	CONFIG TIMEOUT	- - -			
	TIMEOUT	0 and 999	600		Seconds

Structure Diagram	Prompt/Parameter	Parameter Limits	Factory Configuration	User Configuration	Remarks and Notes
5	CONFIG BUFFERS	- - -			If pH
	BUFFERS	AMERICAN, NIST, EUROPEAN, SPECIAL	AMERICAN		
	SPECIAL BUFFER 1	- - -			If SPECIAL
	NUM PTS	02 AND 11	02		
	TEMPx	-99.9 and 999.9	0.00		°C or °F
	VALx	-2.00 and 14.00 pH	0.00		
	SPECIAL BUFFER 2	- - -			
	NUM PTS	02 AND 11	02		
	TEMPx	-99.9 and 999.9	0.00		°C or °F
	VALx	-2.00 and 14.00 pH	0.00		
	SPECIAL BUFFER 3	- - -			
	NUM PTS	02 AND 11	02		
	TEMPx	-99.9 and 999.9	0.00		°C or °F
	VALx	-2.00 and 14.00 pH	0.00		
	CONFIG PASSCODE	- - -			
	PASSCODE MINOR	- - -			
	MINOR	0 AND 9999	0800		
	PASSCODE MAJOR	- - -			
	MAJOR	0 AND 9999	0800		
	CONFIG STRINGS	- - -			
	STRINGS TAG NUM	- - -			
	TAG NUM				
	STRINGS TAG NAME	- - -			
	TAG NAME				
	STRINGS LOCATE	- - -			
	LOCATE				
	STRINGS DEV NAME	- - -			
	DEV NAME				
	CONFIG AC PWR	- - -			
6	AC PWR	60, 50 Hz	60		
	CONFIG DIAGS	- - -			

Structure Diagram	Prompt/Parameter	Parameter Limits	Factory Configuration	User Configuration	Remarks and Notes
6	ALLDIAGS	CLEAR, ENABLE, DISABLE	DISABLE		
	GLASS	CLEAR, ENABLE, DISABLE, LIMIT, CUTOFF T			
	LIMIT	0 - 1100 kOHM			Increments of 100
	CUTOFF T	0.0 and 100.0			50.0
	LEAKAGE	CLEAR, ENABLE, DISABLE			
	LOWSLOPE	CLEAR, ENABLE, DISABLE, LIMIT			
	LIMIT	0.0 and 100.0	80.0		
	PREAMP	CLEAR, ENABLE, DISABLE			
	ATCSHORT	CLEAR, ENABLE, DISABLE			
	ATC OPEN	CLEAR, ENABLE, DISABLE			
	COAT	CLEAR, ENABLE, DISABLE, LIMIT			
	LIMIT	0 - 100 kOHM	80 kOHM		Increments of 10
	AGING	CLEAR, ENABLE, DISABLE			
	4 - 20 RNG	CLEAR, ENABLE, DISABLE			
	COMP RNG	CLEAR, ENABLE, DISABLE			
	MEAS RNG	CLEAR, ENABLE, DISABLE			

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